

Annals of the Missouri Botanical Garden

VOL. 4

FEBRUARY, 1917

No. 1

HYBRID NYMPHAEAS

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During the last four years the collection of nymphaeas at the Garden has been greatly augmented and the area for carrying on experiments considerably increased. This has offered the writer greater opportunities for intercrossing and also for growing a larger number of fully developed plants during the summer months. Up to the present time it has been impossible to determine the law of heredity in the results obtained, but some interesting factors have appeared in the hybrids of *Nymphaea flavo-virens* Lehm., a species of Mexico, and *Nymphaea capensis* var. *zanzibariensis* (Casp.) Conard, native of Africa.

In 1912 *N. flavo-virens* ♀ was crossed with the blue-flowered form of *N. capensis* var. *zanzibariensis* ♂, and also with the light pink form, namely, *N. capensis* var. *zanzibariensis* f. *rosea* ♂. The hybrids from both crosses have been in the trade for several years, the former known as *Nymphaea* "William Stone" and the latter as "Mrs. C. W. Ward." Both are given as sterile by Dr. H. S. Conard in his 'Monograph of the Genus *Nymphaea*,' but those raised at the Garden produced at least 25 per cent of fertile seed, this factor allowing the work to be carried further.

Both varieties were subsequently self-pollinated. "Mrs. C. W. Ward," in the second generation, produced light pink, dark pink, and blue flowers, the light pink being identical with

Nymphaea "Stella Gurney." This undoubtedly proves the parentage of the original "Stella Gurney," which, according to Mr. James Gurney, was a spontaneous seedling through insect agency. The seeds of the *Brachyceras* group are carried over the winter in the ponds outside, and readily germinate the next season during May, while those of *Euryale ferox* germinate even if the ponds have been drained. *Nymphaea* "William Stone" produced the same breaking up into blues and pinks as "Mrs. C. W. Ward," and there was no indication florally of the pistillate parent, *N. flavo-virens*, in either cross, but it was evident in the tubers and in the extremely long petioles.

Reciprocal crosses were also made between $(FV \varnothing \times Z \delta) \varnothing \times (FV \varnothing \times Z \text{ rosea } \delta) \delta$ and $(FV \varnothing \times Z \text{ rosea } \delta) \varnothing \times (FV \varnothing \times Z \delta) \delta$.¹ The only result attained was the intensifying of the color of the flowers, whereas the same gradation of the blues and pinks appeared. A final cross $([FV \varnothing \times Z \delta] \varnothing \times [FV \varnothing \times Z \text{ rosea } \delta]) \varnothing \times ([FV \varnothing \times Z \text{ rosea } \delta] \varnothing \times [FV \varnothing \times Z \delta]) \delta$ produced a great variation from light pink to violet. The violet variety having the small floral character was nearest to the parent, *N. flavo-virens*, to date. As this factor was unusual, the flowers were carefully emasculated and self-pollinated. During 1915 ten plants were raised and finally planted out in 1916 for the summer development. The result was six plants of *N. capensis* var. *zanzibariensis*, the blue-flowered form, and four of *N. capensis* var. *zanzibariensis* f. *rosea*, the original pink form. There was no indication in either tuber or flowers of *N. flavo-virens*. The appearance of *zanzibariensis* types is interesting, especially as the type material had not been in the collection for two seasons.

The impossibility of suggesting the law of heredity can readily be seen when some characters are entirely absent and others are intensified in the offspring. Another factor to bear in mind is that nymphaeas contain several hundred seeds in one carpel, while one ovary may contain twenty to forty carpels, thus aggregating thousands of seeds in one pod. To

¹ FV = *N. flavo-virens*; Z = *N. capensis* var. *zanzibariensis*; Z rosea = *N. capensis* var. *zanzibariensis* f. *rosea*.

raise all plants required in working out the Mendelian law would necessitate a larger water area than the total area of the Garden.

× NYMPHAEA CASTALIIIFLORA PRING, N. HYB.

(*Nymphaea capensis* var. *zanzibariensis* ♀ × *Nymphaea capensis* var. *zanzibariensis* ♂).

This pink-flowered hybrid is the result of intercrossing two light pink races of *N. capensis* var. *zanzibariensis* during 1912, the progeny being a great improvement over any previous hybrid. It was self-pollinated, with the object of fixing the

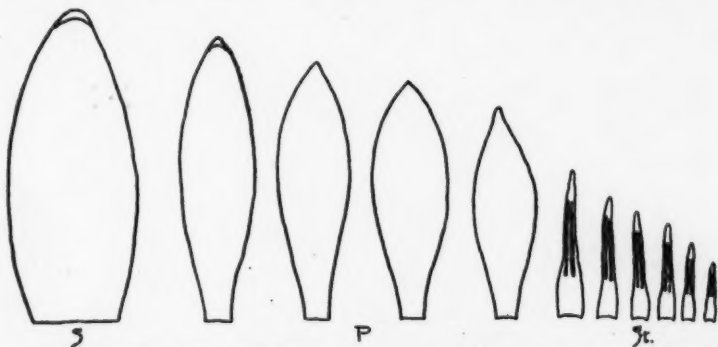


Fig. 1. *Nymphaea castaliiflora*: S, sepal; P, petals; St, stamens. One-half natural size.

light pink color, and during the first year one hundred plants were cultivated. The results showed 2 per cent of blue flowers, which, however, were inferior to the pink both in the size and number of the floral segments. The remaining 98 per cent were of the same dominant light pink color, with no variation, unlike *Nymphaea* "William Stone" and *Nymphaea* "Mrs. C. W. Ward."

The second year of self-pollination revealed flowers with a total exclusion of the blue color, the same dominant pink color being present, and the third year's experiments produced the same results. Therefore, the evidence suggests that this large, semi-double hybrid has become fixed. Homoeosis is well represented in the flower which bears four complete

whorls of petals, while other members of the *Brachyceras* group usually have but three. The arrest of the outer row of stamens is evidenced occasionally by a slight malformation of one or two petals, with indications of the bilocular anthers at the apex. The flower suggests the subgenus *Castalia* by its subconical buds and the open petals which rest on the surface of the water during the third and fourth day.

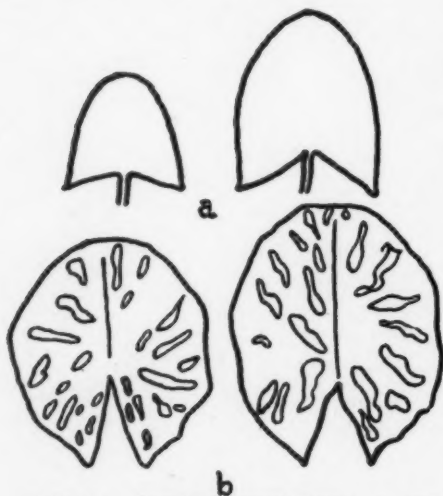


Fig. 2. *Nymphaea castaliiflora*: a, submerged leaves of seedling; b, first floating leaves. Natural size.

Description.—

Flowers 8–10 inches across, opening 5–6 successive days from 7 A. M. to 6:30 P. M. during August, 4–6 open at one time, extremely fragrant; bud ovate to ovate-conical, light green; peduncle rising 7 inches above water, in cross-section showing 6 main air-canals surrounded by 12, these again by 24 smaller ones; receptacles yellow; sepals 4-wedged, ovate, $3\frac{1}{2}$ inches long, $1\frac{1}{2}$ inches

wide, prominently hooded at the apex, thick, fleshy in texture, outer surface light green with pink margins, inner surface light pink, light green at the base, showing 10–15 nerves; petals 45–60; outermost whorl lanceolate, obtuse, slightly hooded at the apex, $3\frac{1}{2}$ inches long, $\frac{1}{2}$ –1 inch wide, with the outer surface light pink channeled longitudinally with green, thickish in texture except along the margins, 7–8-nerved, and the inner surface light pink; the inner whorls pink, slightly acute, becoming shorter, narrower, and sub-acuminate towards the center; stamens 300–325; outermost whorl $1\frac{1}{4}$ inches long, with appendages ovate-oblong at the base, yellow, pink at the apex; the inner whorls

shorter and narrower toward the innermost, which is linear and white at the apex; carpels 45-50, with styles oblong, obtuse, introrse, yellow; fruit globose, containing numerous fertile seeds if pollinated through insect agency, not producing many when artificially pollinated; leaves of submerged seedling light green, broadly triangular, with acute lobes; first floating leaves orbicular with undulated margins, green prominently blotched with reddish brown on the upper surface, dark pink to pinkish red beneath; developed leaves orbicular, 1 foot 3 inches across, peltate, obtusely sinuate-dentate, green sparsely spotted with light brown on the upper surface, reddish pink beneath; sinuses overlapping; petioles brown, often attaining a length of 6 feet when fully developed.

× NYMPHAEA "MRS. EDWARDS WHITAKER" PRING, N. HYB.

(*Nymphaea ovalifolia* ♀ × *Nymphaea castaliiflora* Pring ♂.)

The recent introduction of seeds of *Nymphaea ovalifolia* Conard from Africa by the Bureau of Plant Introduction, of Washington, D. C., and their successful germination by Mr. E. T. Harvey, of Cincinnati, has placed the much-needed material before the hybridist.

Seeds of *N. ovalifolia* were sent from the Harvey collection and raised at the Garden during 1915. This species is a strong-growing type, producing large white flowers, but with one defective feature—the small number of petals. A large number of the plants raised produced both blue and pink at the tips of the petals. To counterbalance this defect in the perianth this species was crossed with the semi-double *N. castaliiflora*, the latter being used as the pollen parent. The fertilization was accomplished at the first trial, *N. ovalifolia* being very receptive to artificial pollination. The reciprocal cross was made repeatedly with no results. The seeds of the hybrid, *N. ovalifolia* ♀ × *N. castaliiflora* ♂, germinated readily, and during the summer months produced the largest flowers of any of the *Brachyceras* types. The color of the flowers varied from lavender-blue to dark blue. This color was retained for the first few days, then an unusual factor appeared—the blue color bleaching to almost white and the lavender-

blue to pure white. The dominance of the blue color is contrary to the results with the *N. flavo-virens* ♀ × *N. capensis* var. *zanzibariensis* f. *rosea* ♂ cross, no doubt being derived from *N. ovalifolia*, as the pink *N. castaliiflora* is apparently fixed. It suggests that *N. ovalifolia* is derived from a blue parent.

There are two separate leaf characters which warrant a segregation: (1) a distinct marmoration on the upper sur-

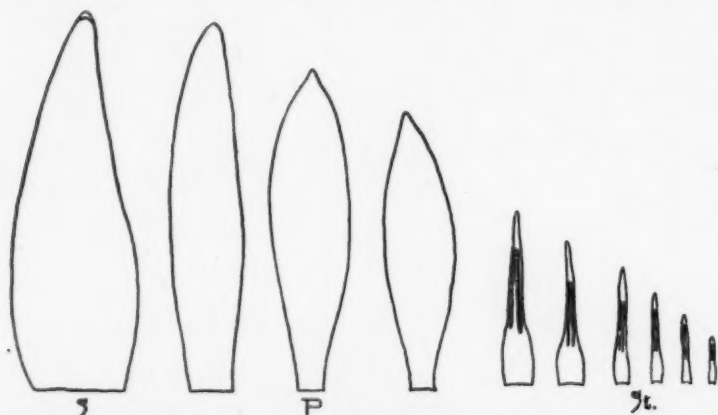


Fig. 3. *Nymphaea* "Mrs. Edwards Whitaker": S, sepal; P, petals; St, stamens. One-half natural size.

face of the leaves, which is obtained from both parents, plainly evident in the seedling leaves only of *N. castaliiflora* and in both seedling and developed leaves of *N. ovalifolia*; (2) the dark green color of the upper surface and the light green densely spotted with purplish blue on the under side, this being the dominant leaf character. The former is characterized below as a horticultural variety *marmorata*.

Some parental characters are plainly evident, and others are exaggerated; as, for instance, the number of petals and stamens are intermediate, showing an increase over the pistillate parent and a decrease from that of the staminate side. The outer petals are hooded and show the influence of *N. castaliiflora*, and an improvement over either parent is evident in the size of the flower. The prominent markings on

the sepals show a decided increase over *N. ovalifolia*, whereas in *N. castaliiflora* they are entirely absent. The seed pods contain a very low percentage of fertile seed compared with either parent. The main air-canals in the peduncle suggest *N. ovalifolia*. The leaves are fairly intermediate, sub-orbicular, with deeply sinuate margins, and the under side shows an increase of maculations over *N. ovalifolia*, from which parent they are transfused. The red color on the under side of the seedling leaves suggests *N. castaliiflora*, this factor, however, being lost in the developed leaves of the type plant. The leaves of the variety *marmorata* show a reddish pink color, with the marmorations intensified in the upper surface. This intensifying of some factors which are only transfused from a single parent is interesting. Previously described hybrids which contain *N. caerulea*, the Egyptian blue lily, show the same peculiarity.

Description.—Flowers 10–11 inches across, opening from 5 to 6 successive days from 6:30 A. M. to 7 P. M. during August, 4–8 open at one time, extremely fragrant; bud narrowly ovate-acuminate, dark green prominently striped with dark purple; peduncle rising 1 foot above the water, in cross-section showing 7–8 main air-canals circled by 14–16 smaller ones, these again irregularly surrounded by still smaller air-canals; sepals 4-wedged, ovate, $4\frac{1}{2}$ inches long, $1\frac{1}{2}$ inches wide, slightly hooded at the apex, thick, fleshy in texture, outer surface dark green prominently striped with dark purple, lavender-blue on the margins, inner surface lavender-blue, light green at the base, showing 10–15 nerves; petals 30–35, comprising three whorls; the outermost lanceolate, obtuse, $4\frac{1}{2}$ inches long, 1 inch wide, with the outer surface lavender-blue bleaching to white, channeled with green and striped with purplish lines, thickish in texture except along the margins, 6–8-nerved, and the inner surface lavender-blue bleaching to white; the inner whorls lanceolate, acute, becoming shorter toward the center, lavender-blue bleaching to white; stamens 170–180; outermost whorl $2\frac{1}{2}$ inches long, with appendages ovate-oblong at the base, yellow, linear above, lavender-blue at the apex; inner whorls becoming shorter and narrower toward

the innermost, which is linear and white at the apex; carpels 30-35, with styles oblong, obtuse, introrse, yellow; fruit globose, containing a low percentage of fertile seeds; leaves of submerged seedling light green, linear-ovate to deltoid, with

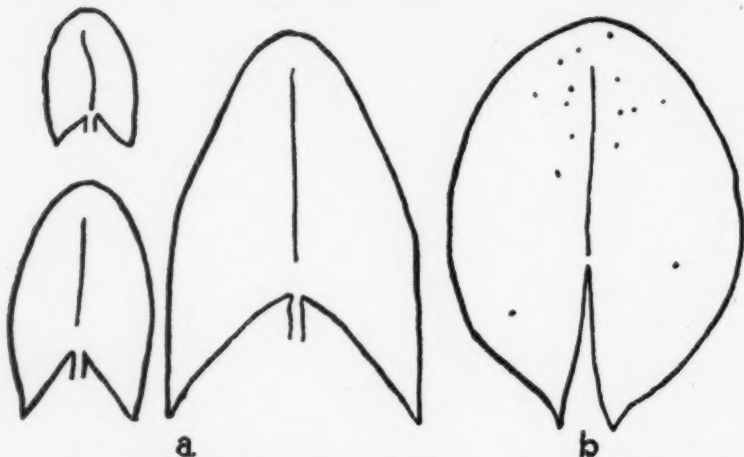


Fig. 4. *Nymphaea* "Mrs. Edwards Whitaker": a, submerged leaves of seedling; b, first floating leaf. Natural size.

acute lobes; first floating leaves ovate, light green occasionally spotted with dark green on the upper surface, dark red densely spotted with purplish blue on the under side; developed leaves narrowly peltate, suborbicular, 1 foot 3 inches across with deeply sinuate margins, almost entire at the apex; sinuses overlapping, terminating into ovate, acuminate lobes, dark green on the upper surface, rarely spotted with brownish green at the base, the under surface light green densely spotted with purplish blue spots, becoming smaller towards the margin; petioles dark green, often measuring 8-10 feet when fully developed.

× NYMPHAEA "MRS. EDWARDS WHITAKER" HORT. VAR. MARMORATA PRING, N. VAR.

Description.—Flowers same as in the type; leaves of submerged seedling light green spotted with dark green on the upper surface, linear-ovate to deltoid, lobes acute; first float-

ing leaves ovate, light green irregularly blotched with reddish brown on the upper surface, dark red densely spotted with purplish blue on the under side; developed leaves narrowly peltate, suborbicular, with deeply sinuate margins, almost

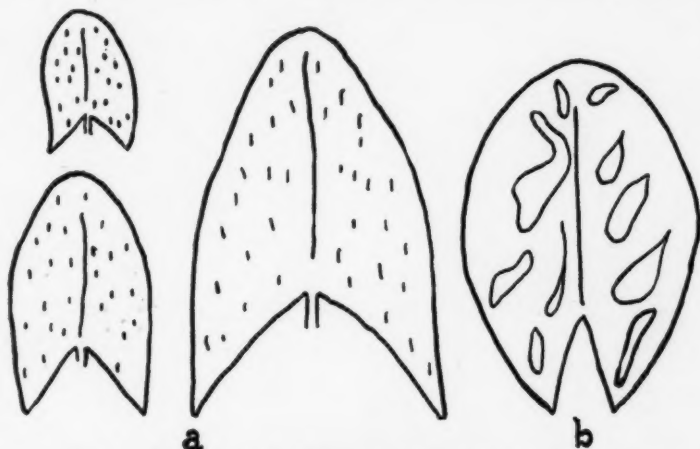


Fig. 5. *Nymphaea* "Mrs. Edwards Whitaker" hort. var. *marmorata*: a, submerged leaves of seedling; b, first floating leaf. Natural size.

entire at the apex; sinuses overlapping, terminating into ovate-acuminate lobes, prominently blotched with dark red on the upper surface, slightly fading on the old leaves, light green shaded with pink and spotted with purplish blue on the under side.

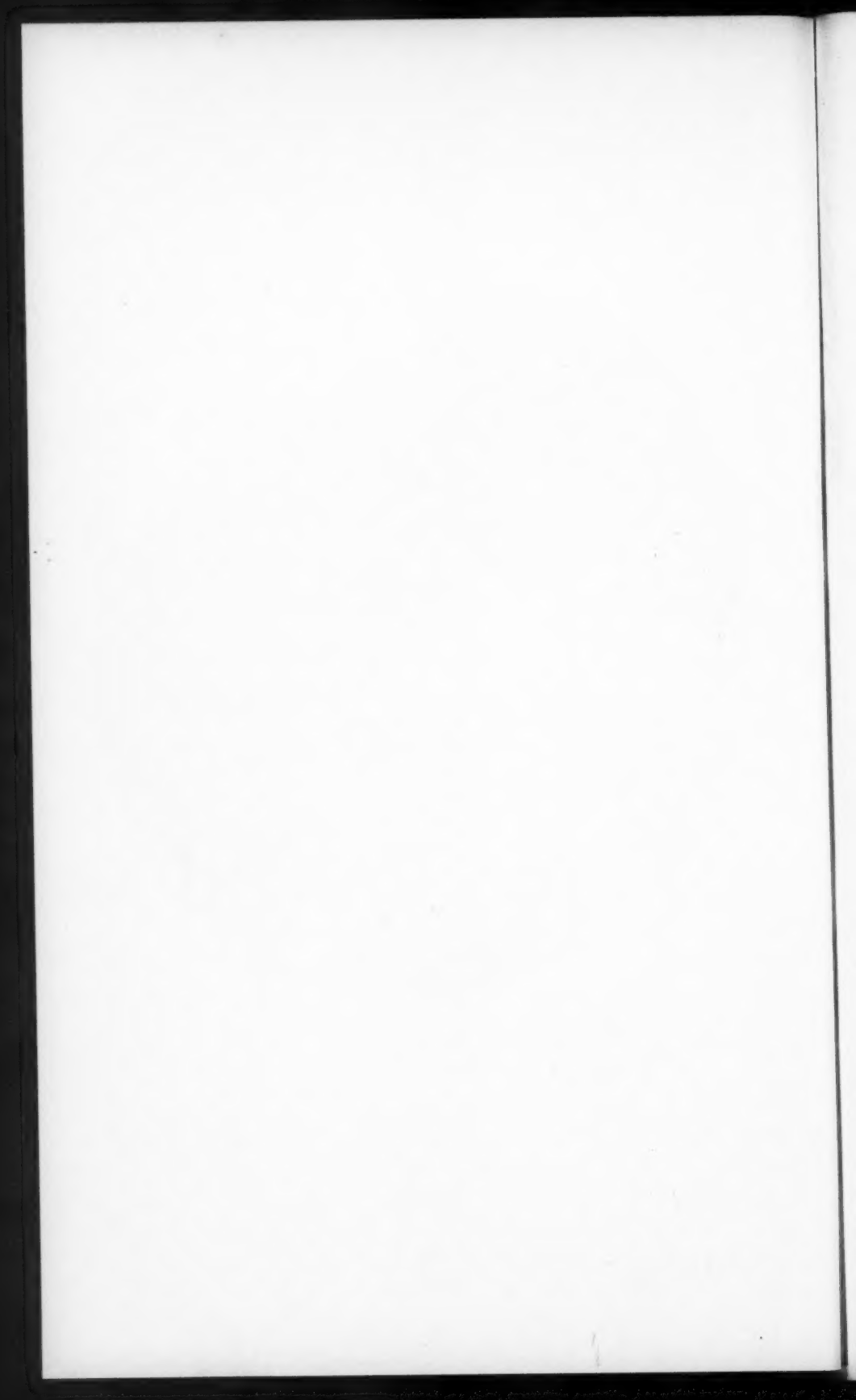
EXPLANATION OF PLATE

PLATE 1

Nymphaea "Mrs. Edwards Whitaker" Pring, n. hyb. One-third natural size.



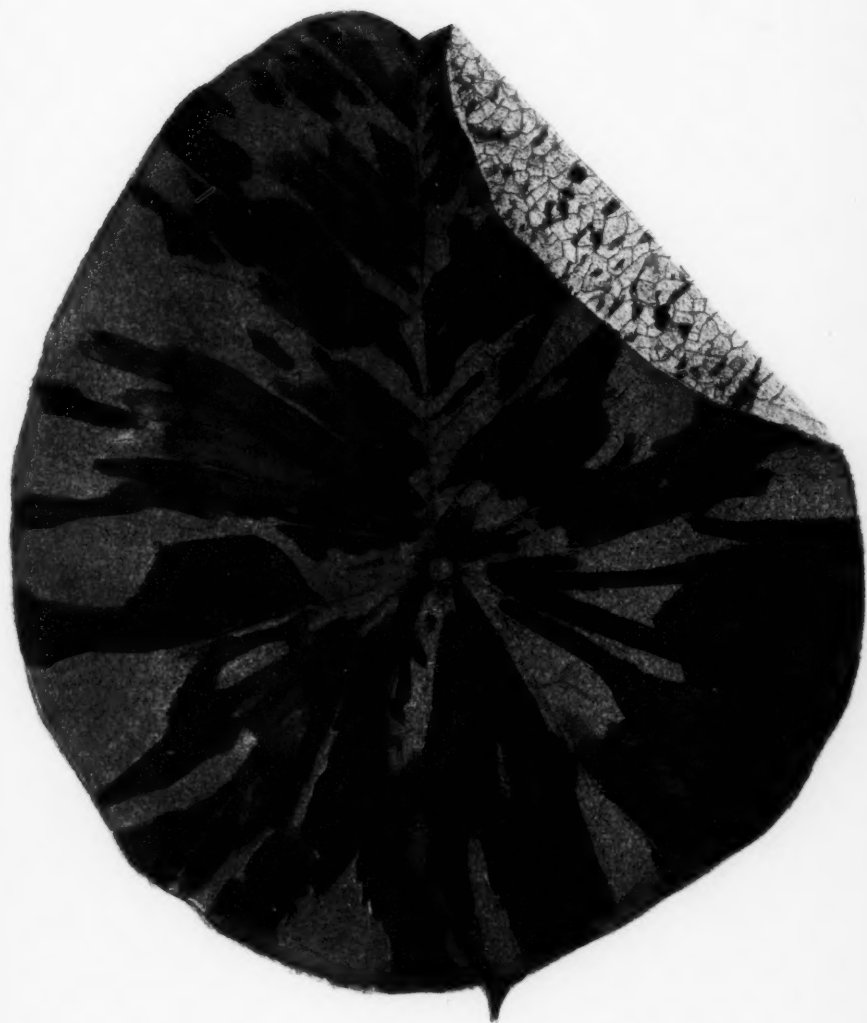
NYMPHAEA "MRS. EDWARDS WHITAKER" PRING



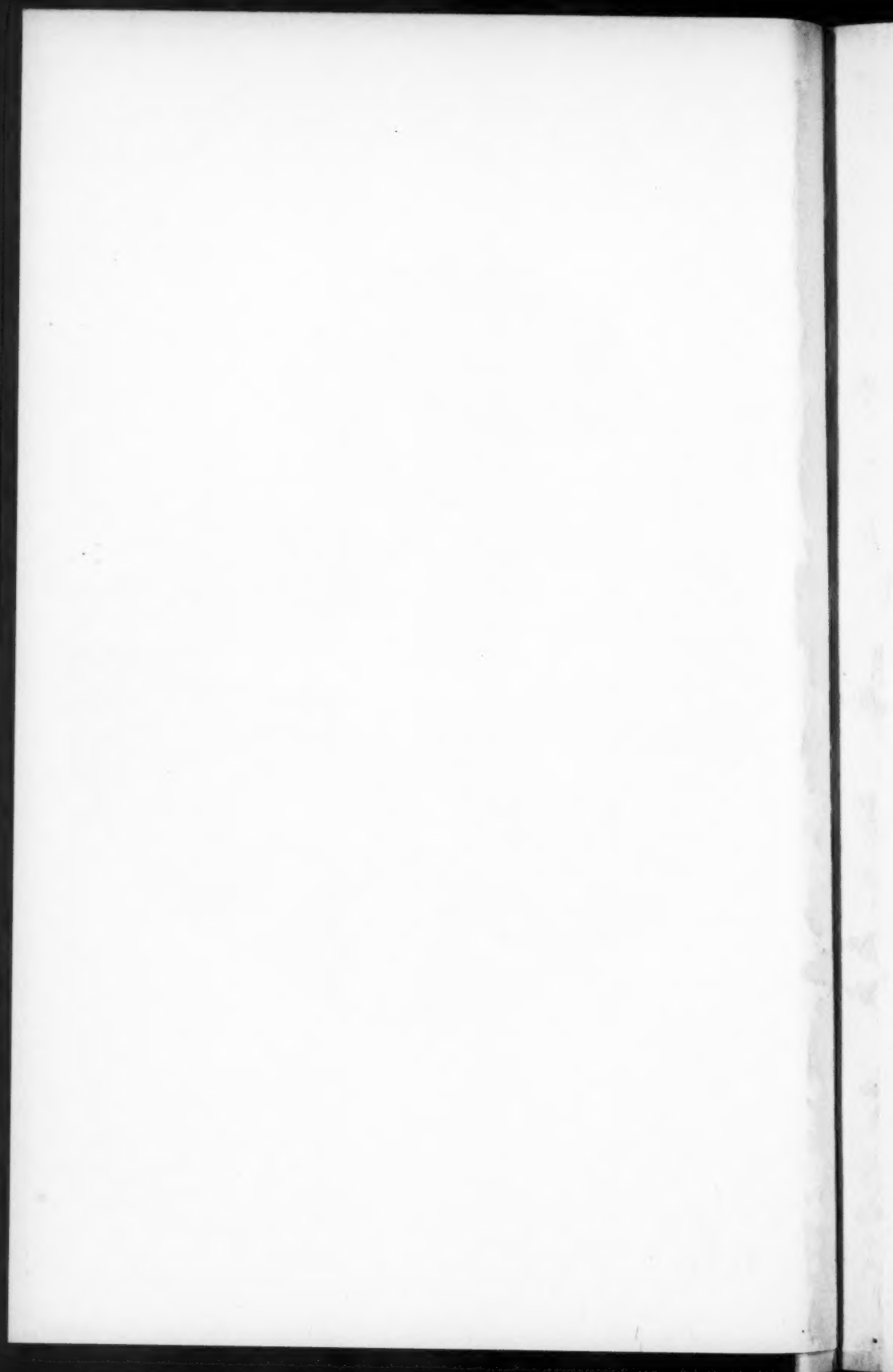
EXPLANATION OF PLATE

PLATE 2

Leaf of *Nymphaea* "Mrs. Edwards Whitaker" hort. var. *mar-*
morata Pring, n. var. One-third natural size.



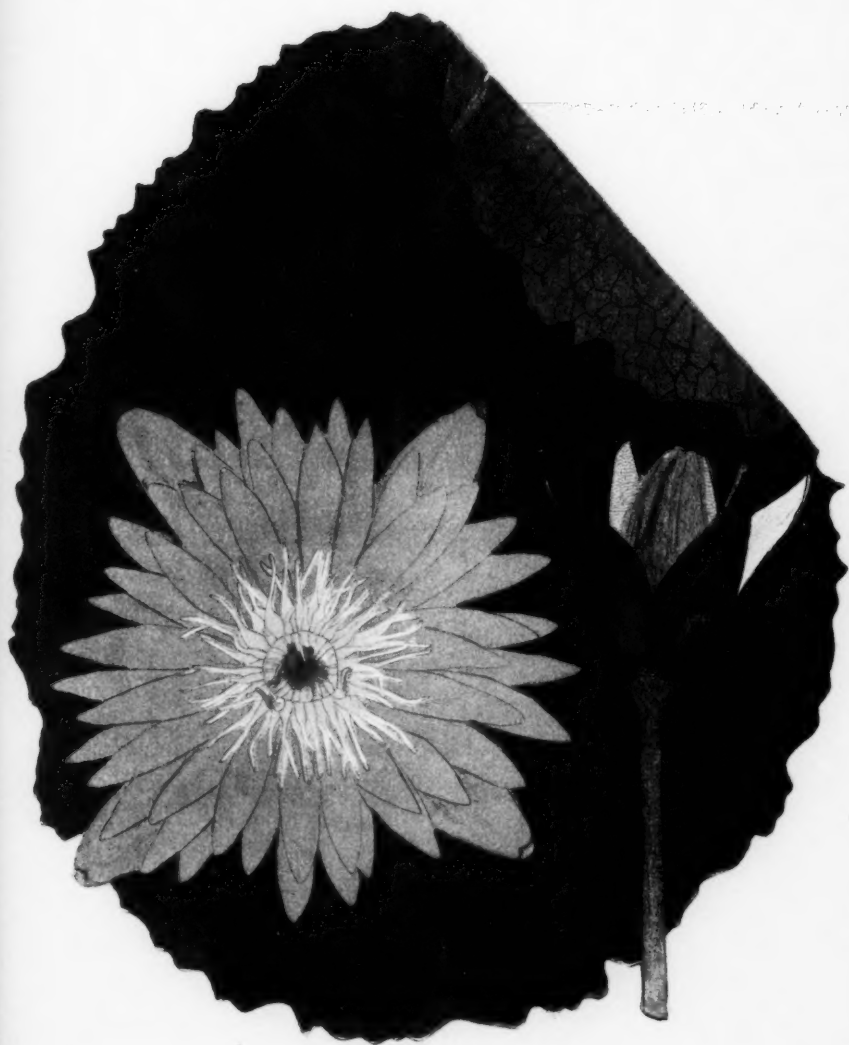
LEAF OF NYMPHAEA "MRS. EDWARDS WHITAKER" VAR. MARMORATA PRING



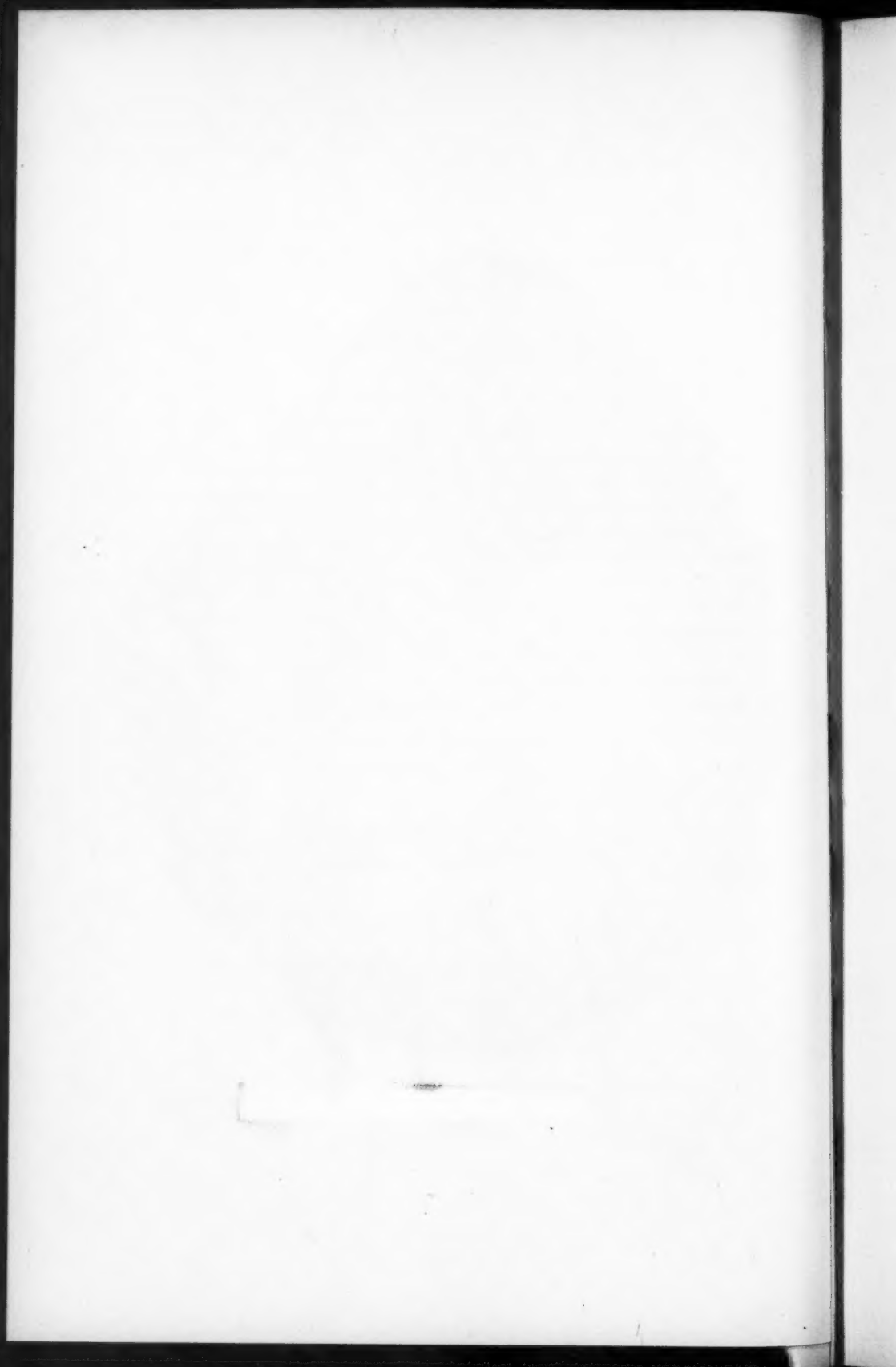
EXPLANATION OF PLATE

PLATE 3

Nymphaea castaliiflora Pring, n. hyb. One-third natural size.



NYMPHAEA CASTALIIFLORA PRING



MONOGRAPH OF THE NORTH AND CENTRAL AMERICAN SPECIES OF THE GENUS SENECIO — PART II¹

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SECT. 7. LOBATI Rydb.

§7. LOBATI Rydb. Bull. Torr. Bot. Club 27: 169. 1900, in part; Greenm. Monogr. Senecio, I. Teil, 22, 24, 29, 30. 1901, and in Engl. Bot. Jahrb. 32: 18, 20, 25, 26. 1902.

Herbaceous perennials, glabrous or white floccose-tomentulose in the early stages and more or less glabrate, rarely permanently tomentose throughout; stems erect or ascending, 1 to 10 dm. high, one to several from a common base or rootstock; foliage variable but mostly pinnatifid; the earliest leaves obovate or oblanceolate and undivided to lyrate; heads radiate or occasionally discoid; achenes usually striate, glabrous or hirtellous along the angles. Plants of western United States and northern Mexico. Sp. 81-96.

KEY TO THE SPECIES

- A. Heads medium in size, 8 to 10 mm. high, radiate or rarely discoid.
 - a. Achenes usually hirtellous.
 - α. Involucral bracts about 13.
 - I. Stems about 3 dm. or less high; leaf-segments narrow, rather remote.....81. *S. multilobatus*
 - II. Stems 4 to 5 dm. high, leafy; leaf-segments broader82. *S. lapidum*
 - β. Involucral bracts about 21.
 - I. Stems uniformly leafy.....83. *S. millelobatus*
 - II. Stems not uniformly leafy.....84. *S. parrasianus*
 - b. Achenes usually glabrous.
 - α. Involucral bracts 13; heads discoid.....85. *S. leucoreus*
 - β. Involucral bracts usually 21; heads radiate.
 - I. Lower leaves subbipinnate or deeply pinnatisect into numerous small divisions....86. *S. lynceus*
 - II. Lower leaves obovate or oblanceolate and dentate to lyrate pinnatifid, not bipinnate.

¹ Issued March 9, 1917.

NOTE.—The present paper is continued from Ann. Mo. Bot. Gard. 3: 85-194. 1916.

1. Stems rather slender; neither stem nor leaves glaucous.
 - * Leaves thickish in texture, more or less tomentulose in the early stages.
 - † Upper leaves appressed to the stem; ray-flowers about 13...87. *S. scalaris*
 - †† Upper leaves spreading; ray-flowers 8 to 10.
 - ‡ Radical leaves oblanceolate, dentate, .5 to 1.5 cm. broad88. *S. Thorneri*
 - ‡‡ Radical leaves obovate and dentate to lyrate, .5 to 2.5 cm. broad89. *S. uintahensis*
 - ** Leaves thin in texture, glabrous except at the base of the petioles....90. *S. stygius*
2. Stems stout and, as well as the leaves, glaucous91. *S. quercetorum*
- B. Heads larger, 10 to 20 mm. high, radiate.
 - a. Stems low, 1 dm. or less high; plants of Arizona...92. *S. franciscanus*
 - b. Stems 1 to 8 dm. high; plants of California.
 - a. Leaves relatively large, lyrate pinnatifid with numerous lateral lobes.
 - I. Plants glabrous or with a slight tomentum in the leaf-axils; upper stem-leaves irregularly pinnatisect93. *S. Breweri*
 - II. Plants at first tomentulose, later more or less glabrate; upper stem-leaves regularly pinnatifid94. *S. eurycephalus*
 - β. Leaves merely lacinate-dentate.....95. *S. Austinae*
 - γ. Leaves relatively small, obovate and undivided to lyrate with few small lateral lobes.....96. *S. ionophyllus*

81. *S. multilobatus* Torr. & Gray, ex Gray in Mem. Am. Acad. 4: 109. 1849; Eaton in Bot. King's Exp. 191. 1871, in part, as to description and plant of Fremont; Gray, Syn. Fl. N. Am. 1²: 394. 1884, and ed. 2, 1886, in part; Rydb. Bull. Torr. Bot. Club 27: 172. 1900, in part; Greenm. Monogr. Senecio, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. 32: 20. 1902; Wootton & Standley, Contr. U. S. Nat. Herb. 19: 747. 1915.

S. aureus var. *multilobatus* Gray in Bot. Calif. 1: 411. 1876, in part.

An herbaceous perennial; stems one to several from a common base, erect, 1.5 to 4 dm. high, simple or branched, glabrous or tomentulose in the axils of the leaves, striate, stramineous or somewhat purplish in the dried state; radical and lower stem-leaves petiolate, oblanceolate to subspatulate in general outline, including the petiole 2 to 10 cm. long, .5 to 2 cm. broad, undivided and merely dentate toward the

apex to sublyrately pinnatifid, lightly floccose-tomentulose to glabrous; upper stem-leaves sessile, pinnately divided into linear-oblong and subentire to obovate-cuneate obtusely or acutely dentate rather remote divisions, occasionally much reduced; inflorescence a terminal few to several-headed corymbose cyme; heads 8 to 10 mm. high, radiate; involucre campanulate, sparingly calyculate, glabrous; bracts of the involucre usually 13, linear-lanceolate, acute, 5 to 8 mm. long; ray-flowers 5 to 8, rays yellow; disk-flowers 20 to 40; achenes hirtellous.

Distribution: southwestern Wyoming to New Mexico, west to Nevada.

Specimens examined:

Utah: "on the Uinta River, in the interior of California," *Fremont* (Gray Herb. and Torrey Herb.), TYPE; Kanab, coll. of 1872, *Mrs. A. P. Thompson* (Gray Herb. and U. S. Nat. Herb.); St. George, coll. of 1875, *E. Palmer* (Gray Herb. and Mo. Bot. Gard. Herb.); "Sierra La Sal Pers," May-Oct., 1899, *Purpus* (U. S. Nat. Herb. No. 505317); near Wilson Mesa, Grand Co., alt. 1600 m., 1 July, 1911, *Rydberg & Garrett 8393* (U. S. Nat. Herb. and Univ. Calif. Herb.).

Colorado: Naturita, alt. 1645 m., 27 April, 1914, *Payson 258* (Mo. Bot. Gard. Herb.); dry arroyo sides, Paradox, Montrose Co., alt. 1645 m., June, 1912, *Walker 99* (U. S. Nat. Herb. and Mo. Bot. Gard. Herb.); in dry fields, Mancos, alt. 2130 m., 8 July, 1898, *Baker, Earle & Tracy 446* (Mo. Bot. Gard. Herb.), previously included with *S. tridenticulatus*; along Kyser Creek, on the Grand Mesa, Delta Co., *Purpus 222* (Univ. Chicago Herb. at Field Mus. No. 357369); Grand Junction, May, 1892, *Eastwood* (Univ. Calif. Herb. No. 91435).

Wyoming: sage-brush flats, Henry's Fork, Uinta Co., 26 June, 1902, *Goodding 1194* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.).

Nevada: vicinity of Pioche, Lincoln Co., 9 June, 1909, *Miss Maud Minthorn 44* (Univ. Calif. Herb.).

Var. **Standleyi** Greenm. var. nov.

Stems several, 1.5 to 2 dm. high, slender, leafy at the base, nearly naked above; leaves oblanceolate and sparingly den-

tate to sublyrate or even subbipinnate, thickish in texture, glabrous or sparingly tomentulose; inflorescence and technical characters of the head like the species.

Specimens examined:

New Mexico: dry hills, vicinity of Farmington, San Juan Co., alt. 1550-1650 m., 19 July, 1911, *Standley 7080* (U. S. Nat. Herb.), TYPE; dry hills, Navajo Indian Reservation, about the north end of Carrizo Mountains, 3 Aug., 1911, *Standley 7513* (U. S. Nat. Herb.); vicinity of Cedar Hill, San Juan Co., alt. about 1900 m., 17 Aug., 1911, *Standley 8032* (U. S. Nat. Herb.); north of Ramah, 25 July, 1906, *Wootton* (U. S. Nat. Herb.).

The variety *Standleyi* resembles certain forms of *S. tridenticulatus* Rydb., through which forms the present group is connected with the section *Aurei*.

82. *S. lapidum* Greenm.¹

An herbaceous perennial; stems one to several from a common base, erect, simple or branched, 3 to 5 dm. high, striate, glabrous; radical and lower stem-leaves petiolate, lyrate-pinnatifid into rather numerous oblong-cuneate dentate lateral lobes, including the petiole 4 to 10 cm. long, 1 to 2.5 cm. broad, white floccose-tomentulose in the early stages, later becoming glabrous or nearly so; inflorescence a terminal corymbose cyme; heads 8 to 10 mm. high, radiate; involucre campanulate, sparingly calyculate, glabrous; bracts of the

¹ *Senecio lapidum* Greenm. sp. nov., herbaceus perennis; caulibus solitariis vel subcaespitosis simplicibus vel parce ramosis erectis 3-5 dm. altis striatis glabris foliaceis; foliis radicalibus et inferioribus petiolatis lyrato-pinnatifidis petiolo incluso 4-10 cm. longis 1-2.5 cm. latis primo parce albo-floccoso-tomentulosis plus minusve glabratibus, segmentis foliorum oblongo-cuneatis dentatis; foliis superioribus sessilibus pinnatifidis; inflorescentiis terminalibus corymbocymosis; capitulis numerosis 8-10 mm. altis radiatis; involucri campanulatis parce calyculatis glabris; bracteis involucri lineari-lanceolatis 5-7 mm. longis acutis; floribus femineis plerumque 8, ligulis flavibus; floribus disci 25-40; acheniis hirtellis.—Utah: Silver Reef, alt. 1065-1220 m., 3 May, 1894, *M. E. Jones 5163a* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.), TYPE, and *5149* (U. S. Nat. Herb. and Univ. Calif. Herb.); Johnson, Kane Co., 23 May, 1894, *M. E. Jones 5289g* (U. S. Nat. Herb.).

This species is closely related to *S. multilobatus* Torr. & Gray to which the specimens here cited have been hitherto referred, but it differs from the Torrey and Gray species in being a somewhat stouter plant, in having a more leafy stem lyrate lower leaves with broader leaf-segments, and in having a thinner leaf-texture.

involucre linear-lanceolate, 5 to 7 mm. long; ray-flowers commonly 8, rays yellow; disk-flowers 25 to 40; achenes hirtellous.

Distribution: southern Utah.

Specimens examined:

Utah: Silver Reef, in Utah Gravel, alt. 1065-1220 m., May, 1894, *M. E. Jones 51630* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.), TYPE, and *5149* (U. S. Nat. Herb. and Univ. Calif. Herb.); Johnson, Kane Co., 23 May, 1894, *M. E. Jones 5289q* (U. S. Nat. Herb.).

83. *S. millelobatus* Rydb. Bull. Torr. Bot. Club **27**: 171. 1900; Greenm. Monogr. Senecio, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. **32**: 20. 1902.

S. Tampicanus Gray, Pl. Wright., part 1, 125. 1852, and part 2, 99. 1853.

S. multilobatus Gray, Syn. Fl. N. Am. **1**²: 394. 1884, and ed. 2, 1886, in part, not Torr. & Gray.

An herbaceous perennial, glabrous or slightly tomentulose in the early stages and soon glabrate except in the axils of the leaves; stems one to several from a common base, 1.5 to 4 dm. high, simple or branched, leafy to the inflorescence; leaves lanceolate to oblanceolate in general outline, 1.5 to 10 cm. long, .5 to 2 cm. broad, pinnately parted into numerous obovate to cuneate dentate divisions; lower leaves petiolate, the upper sessile; inflorescence a terminal few to many-headed corymbose cyme; heads 7 to 9 mm. high, radiate; involucre campanulate, sparingly calyculate; bracts of the involucre usually about 21, linear-lanceolate, 5 to 6 mm. long, glabrous; ray-flowers 8 to 12, rays yellow; disk-flowers 35 to 50; achenes hirtellous.

Distribution: western Texas to Arizona and northern Mexico.

Specimens examined:

New Mexico: hills on the Limpia, coll. of 1851-52, *Wright 1287* (Torrey Herb., Gray Herb., U. S. Nat. Herb., Phil. Acad. Nat. Sci. Herb., and Mo. Bot. Gard. Herb.), TYPE.

Texas: valley of the Rio Grande, below Doñana, *Parry 658*

(U. S. Nat. Herb.); Limpia Cañon, coll. of 1889, *Neally 281* [639] (U. S. Nat. Herb.).

Arizona: Fort Whipple, 25 April, 1865, *Coues & Palmer 309* (Mo. Bot. Gard. Herb.) and in the same locality, May, 1865, *Coues & Palmer 329* (Gray Herb. and Mo. Bot. Gard. Herb.).

Chihuahua: cool shaded places, Santa Eulalia Mountains, 14 Aug., 1885, *Pringle 663* (Gray Herb., U. S. Nat. Herb., and Phil. Acad. Nat. Sci. Herb.).

84. *S. parrasianus* Greenm.¹

An herbaceous perennial; stem erect, about 2 dm. high, rather leafy, striate, glabrous or slightly tomentulose; the first or radical leaves not seen; lower stem-leaves petiolate, oblong-oblancoolate in general outline, including the petiole 3 to 7 cm. long, 1 to 2.5 cm. broad, sublyrately pinnatifid into oblong-cuneate dentate lateral divisions, glabrous or lightly floccose-tomentulose; inflorescence a terminal corymbose cyme; heads 8 to 10 mm. high, radiate; involucre campanulate, calyculate, glabrous; bracts of the involucre usually 21, linear-lanceolate, 5 to 6 mm. long; ray-flowers 10 to 12, rays a rich yellow; disk-flowers about 60; mature achenes 2 to 2.5 mm. long, hirtellous.

Distribution: mountains of northern Mexico.

Specimens examined:

Coahuila: Sierra de Parras, July, 1910, *C. A. Purpus 4575* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Field Mus. Herb.), TYPE.

This species was distributed as "*Senecio lobatus* Gray," under which name it may be found in herbaria.

¹ *Senecio parrasianus* Greenm. sp. nov., herbaceus perennis; caule erecto circiter 2 dm. alto, foliaceo, striato, glabro vel parce tomentuloso; foliis inferioribus caulibus petiolatis in circumscriptione oblongo-oblancoolatis petiolo incluso 3-7 cm. longis 1-2.5 cm. latis sublyrato-pinnatifidis cum segmentis oblongo-cuneatis dentatis lateralibus glabris vel parce floccoso-tomentulosus; inflorescentia terminalibus corymboso-cymosis; capitulis 8-10 mm. altis, radiatis; involucre campanulato calyculato glabro; bracteis involucri plerumque 21 lineari-lanceolatis 5-6 mm. longis; flosculis liguliferis 10-12, ligulis auranto-flavis; floribus disci circiter 60; achaeniis maturitate 2-2.5 mm. longis, hirtellis.—Collected on the Sierra de Parras, July, 1910, *C. A. Purpus 4575* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Field Mus. Herb.), TYPE.

85. *S. leucoreus* Greenm.¹

An herbaceous perennial; stems .5 to 2.5 dm. high, simple or branched from the base, glabrous except in the axils of the leaves, more or less purplish; leaves mostly pinnatifid, at first white-tomentulose, later glabrate, the lateral divisions obovate and dentate or again divided to linear and entire; the lower leaves petiolate, the uppermost sessile and dentate to entire; inflorescence a terminal corymbose cyme; heads 8 to 10 mm. high, discoid; involucre campanulate, sparingly calyculate, glabrous; bracts of the involucre usually 13, linear-lanceolate, 5 to 7 mm. long, acute; disk-flowers about 30; mature achenes 3 mm. long, glabrous.

Distribution: mountains of Nevada.

Specimens examined:

Nevada: on a ridge of limestone formation, south side of Lee Cañon, Charleston Mountains, Clark Co., alt. 2575 m., 26 July, 1913, *A. A. Heller 11003* (Mo. Bot. Gard. Herb. No. 746961, U. S. Nat. Herb. No. 767010, Univ. Calif. Herb. No. 175161, and Field Mus. Herb. No. 411575), **TYPE**; White Mountains, May-Oct., 1898, *Purpus 5817a* (U. S. Nat. Herb. No. 348096, and Univ. Calif. Herb. No. 131548).

86. *S. lynceus* Greene, *Erythea* 3: 22. 1895; Greenm. Monogr. *Senecio*, I. Teil, 24. 1901, and in *Engl. Bot. Jahrb.* 32: 20. 1902.

Plate 4.

S. multilobatus Gray, *Syn. Fl. N. Am.* 1²: 394. 1884, and ed. 2, 1886, in part.

An herbaceous perennial; stems one to several from a common base, erect, 2 to 5 dm. high, striate, stramineous to slightly purplish, leafy at the base, nearly naked above,

¹ *S. leucoreus* Greenm. sp. nov., herbaceus perennis; caulibus erectis 1-2.5 dm. altis simplicibus vel ad basin ramosis glabris vel in axillis foliorum paululo albo-tomentosis plus minusve purpurascens; foliis plerumque pinnatifidis primo albo-tomentosis denique glabris, segmentis lateralis obovatis et dentatis vel integris; foliis inferioribus petiolatis, superioribus sessilibus multo reductis et integris; inflorescentiis terminalibus corymboso-cymosis; capitulis circiter 1 cm. altis, discoideis; involucre campanulato calyculato, glabro; bracteis involucri plerumque 13, lineari-lanceolatis 5-7 mm. longis acutis; floribus disci circiter 30; acheniis 3 mm. longis, glabris.—Collected on a ridge of limestone formation, south side of Lee Cañon, Charleston Mountains, Clark Co., alt. 2575 m., 26 July, 1913, *A. A. Heller 11003* (Mo. Bot. Gard. Herb. No. 746961, U. S. Nat. Herb. No. 767010, Univ. Calif. Herb. No. 175161, and Field Mus. Herb. No. 411575),

TYPE.

glabrous or essentially so; radical and lower stem-leaves obovate to oblong-ob lanceolate in general outline, merely dentate to deeply pinnatifid into relatively small toothed divisions, including the petiole 3 to 10 cm. long, .5 to 1.5 cm. broad, at first usually lightly tomentulose, later more or less glabrate, thickish in texture; upper stem-leaves deeply pinnatisect into small divisions, often much reduced; inflorescence a few to several-headed corymbose cyme; heads 8 to 10 mm. high, radiate; involucre campanulate, sparingly calyculate; bracts of the involucre usually 21 (13-21), linear-lanceolate, 5 to 7 mm. long, glabrous; ray-flowers 8 to 10, rays yellow; disk-flowers 30 to 60; achenes usually glabrous.

Distribution: northern Arizona and adjacent Utah.

Specimens examined:

Arizona: Lynx Creek, 31 May, 1883, *Rusby 665* (Gray Herb., U. S. Nat. Herb. in part, and Mo. Bot. Gard. Herb.); northern Arizona, coll. of 1884, *Lemmon 3263, 3263½* (Gray Herb.); Grand Cañon, alt. 2130 m., May, 1903, *Grant 1192* (Univ. Ariz. Herb.); Grand Cañon, 12 June, 1891, *MacDougal 185* (U. S. Nat. Herb.); Williams, Coconino Co., 1-15 June, 1901, *H. S. Barber 67, 93* (U. S. Nat. Herb.); Colorado Plateau, Grand Cañon, 9 June, 1901, *Ward* (U. S. Nat. Herb. No. 410254); Bright Angel Trail, Grand Cañon, 22 Oct., 1905, *Eastwood 7* (U. S. Nat. Herb.); near Kindrick Mountains, alt. 2000 m., 7 July, 1901, *Leiberg 5662* (U. S. Nat. Herb.); without locality, coll. of 1869, *Dr. E. Palmer* (U. S. Nat. Herb.), form with slightly hirtellous achenes; mesa below Buckskin Mountains, alt. 2135 m., 21 Sept., 1894, *M. E. Jones 6063i* (U. S. Nat. Herb.).

87. *S. scalaris* Greene, Pittonia 4: 108. 1900.

An herbaceous perennial; stem simple, erect, 2 to 6 dm. high, glabrous; basal and lower stem-leaves petiolate, oblong-ovate to oblanceolate, including the petiole 2.5 to 9 cm. long, .5 to 2 cm. broad, crenulate to sublyrate, glabrous or with traces of a white flocculent tomentum; upper stem-leaves sessile, frequently appressed to the stem, pinnately parted into rather numerous short oblong-cuneate subentire to obtusely

dentate lateral lobes; inflorescence a terminal few to several-headed corymbose cyme; heads 8 to 10 mm. high, radiate; involucre campanulate, calyculate; bracts of the involucre usually 21, linear-lanceolate, slightly shorter than the flowers of the disk, glabrous or white tomentulose at the base; ray-flowers about 13, rays bright yellow; disk-flowers 60 to 85; achenes glabrous.

Distribution: mountains of northern Mexico.

Specimens examined:

Chihuahua: near Colonia Garcia in the Sierra Madres, alt. 2315 m., 13 July, 1899, *Townsend & Barber 131* (U. S. Nat. Herb. Nos. 383217, 735374, Gray Herb., and Mo. Bot. Gard. Herb.), TYPE; moist meadows, Guachochic, 25 June, 1892-93, *Hartman 521* (Gray Herb.); in the Sierra Madres, 21 June-29 July, 1899, *E. W. Nelson 6106* (U. S. Nat. Herb.); vicinity of Madera, alt. about 2250 m., 27 May-3 June, 1908, *Dr. E. Palmer 305* (U. S. Nat. Herb.).

Durango: in the Sierra Madres, 48 km. north of Guanacevi, alt. 2435-2745 m., 18 Aug., 1898, *E. W. Nelson 4771, 4778* (U. S. Nat. Herb.); El Oro to Guanacevi, 14-16 Aug., 1898, *E. W. Nelson 4746* (U. S. Nat. Herb.).

88. *S. Thornberi* Greenm.¹

An herbaceous perennial; stems solitary or somewhat cespitose, erect, 1.5 to 3.5 dm. high, glabrous or slightly tomentulose; radical and lower stem-leaves narrowly obovate to oblong-oblancoolate, including the petiole 2.5 to 10 cm. long, .5 to 1.5 cm. broad, crenate-dentate to sublyrate, at first white-

¹ *Senecio Thornberi* Greenm. sp. nov., herbaceus perennis; caulibus solitariis vel caespitosis erectis 1.5-3.5 dm. altis, glabris vel parce tomentulosis; foliis inferioribus anguste obovatis vel oblongo-oblancoolatis et crenato-dentatis vel sublyratis petiolo incluso 2.5-10 cm. longis primo albo-floccoso-tomentulosis denique plus minusve glabris crassiusculis; foliis superioribus sessilibus et pinatifidis aliquando multo reductis et integris; inflorescentiis terminalibus corymboso-cymosis; capitulis numerosis 8-10 mm. altis, radiatis; involuero campanulato parce calyculato glabro vel ad basin tomentuloso; bracteis involucri plerumque 21 (13-21) lineari-lanceolatis 5-7 mm. longis; floribus femineis saepe 8, ligulis flavis; floribus disci 30-65; acheniis glabris.—Arizona: San Francisco Mountains, July, 1883, *Rusby 666* (Gray Herb. and Mo. Bot. Gard. Herb.), TYPE; vicinity of Flagstaff, *Wilson 116* (Univ. Calif. Herb.), *MacDougal 12* (U. S. Nat. Herb., Phil. Acad. Nat. Sci. Herb., Univ. Ariz. Herb., and Gray Herb. in part), *MacDougal 114* (Gray Herb., Phil. Acad. Nat. Sci. Herb., and U. S. Nat. Herb.), *Toumey 706* (U. S. Nat. Herb.), and *Barber 143* (U. S. Nat. Herb.); Mormon Lake, *MacDougal 69* (Gray Herb. and U. S. Nat. Herb.).

floccose-tomentulose, later more or less glabrate, thickish in texture; upper stem-leaves sessile and pinnatifid to entire, often much reduced; inflorescence a terminal corymbose cyme; heads numerous, 8 to 10 mm. high, radiate; involucre campanulate, sparingly calyculate, glabrous or slightly tomentulose at the base; bracts of the involucre usually 21, occasionally fewer (13-21), linear-lanceolate, 5 to 7 mm. long; ray-flowers 8, rays yellow; disk-flowers 35 to 60; achenes glabrous.

Distribution: northern Arizona.

Specimens examined:

Arizona: San Francisco Mountains, July, 1883, *Rusby 666* (Gray Herb. and Mo. Bot. Gard. Herb.), TYPE; Flagstaff, May, 1893, *Wilson 116* (Univ. Calif. Herb.); vicinity of Flagstaff, alt. 1695 m., 31 May, 1898, *MacDougal 12* (U. S. Nat. Herb., Phil. Acad. Nat. Sci. Herb., Univ. Ariz. Herb., and Gray Herb. in part); Mormon Lake, alt. 1825 m., 7 June, 1898, *MacDougal 69* (Gray Herb. and U. S. Nat. Herb.); vicinity of Flagstaff, alt. 2135 m., 15 June, 1898, *MacDougal 114* (Gray Herb., Phil. Acad. Nat. Sci. Herb., and U. S. Nat. Herb.); Flagstaff, 30 June, 1892, *Toumey 706* (U. S. Nat. Herb.); Flagstaff, 6 July, 1901, *H. S. Barber 143* (U. S. Nat. Herb.); Grand Cañon, 12 June, 1891, *MacDougal* (U. S. Nat. Herb. No. 49362, in part).

The specimens here cited have been variously referred to *S. multilobatus* Torr. & Gray, to *S. lynceus* Greene, and to *S. neo-mexicanus* Gray. Habitally it is somewhat intermediate between the two last-mentioned species; and through *S. neo-mexicanus* the present group is connected with the section *Tomentosi*. *S. Thornberi* is named in honor of Professor J. J. Thornber, a distinguished student of the flora of Arizona.

89. *S. uintahensis* (Nelson) Greenm. Monogr. Senecio, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. 32: 20. 1902; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 581. 1909; Garrett, Spring Fl. Wasatch Region, 101. 1911, and ed. 2, 123. 1912.

S. Nelsonii var. *uintahensis* Nelson, Bull. Torr. Bot. Club 26: 484. 1899.

S. Nelsonii var. *utahensis* Nelson, Contr. Fl. Rocky Mountains, in index. 1904.

S. utahensis Nelson, Spring Fl. Intermountain States, 175. 1912.

An herbaceous perennial; stems one to several from a common base, erect or nearly so, 1 to 3.5 dm. high, glabrous or slightly tomentulose, striate, stramineous to somewhat purplish; radical and lower stem-leaves obovate to oblong-ob lanceolate in general outline, mostly lyrate-pinnatifid, lightly floccose-tomentulose to glabrous, thickish in texture, including the petiole 2.5 to 10 cm. long, .5 to 2.5 cm. broad; upper stem-leaves sessile, pinnatifid, often much reduced; inflorescence a terminal usually many-headed corymbose cyme; heads 8 to 10 mm. high, radiate; involucre campanulate, sparingly calyculate; bracts of the involucre usually 21 (occasionally two or more bracts more or less coalescent), linear-lanceolate, 5 to 6 mm. long, glabrous; ray-flowers about 8, rays yellow; disk-flowers 30 to 50; achenes glabrous or rarely slightly hirtellous.

Distribution: Wyoming to Arizona, west to Oregon and eastern California.

Specimens examined:

Wyoming: Evanston, 4 June, 1898, *A. Nelson 4511* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.), co-type; Evanston, 10 July, 1897, *Williams* (U. S. Nat. Herb.); open slopes, Kemmerer, Uinta Co., 13 June, 1900, *Nelson 7172* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.); La Barge, Uinta Co., 7 June, 1894, *Stevenson 208* (U. S. Nat. Herb.); Uinta Mountains, Aug., 1872, *Dr. Joseph Leidy* (Phil. Acad. Nat. Sci. Herb.); dry soil, cañon near Leckie, 23 June, 1901, *Merrill & Wilcox 716* (U. S. Nat. Herb.).

Idaho: Soda Springs, 21 June, 1892, *Mulford* (Gray Herb. and Mo. Bot. Gard. Herb.); near Pocatello, 27 May, 1893, *Dr. E. Palmer 57* (U. S. Nat. Herb.); moist grassy bottom of Port Neuf River, near Pocatello, 23 July, 1897, *Henderson 2998* (Gray Herb.); Pocatello, 27 June, 1902, *Blankinship* (Gray Herb.); on dry slopes, Pocatello, 28 July, 1911, *Nelson &*

Macbride 1401 (U. S. Nat. Herb.); on open sandy hills, M'Cammon, Bannock Co., 15 June, 1899, *A. & E. Nelson 5407* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.).

Utah: plains near Ogden, Hayden's U. S. Geol. Survey, 1871-72, *Coulter* (U. S. Nat. Herb. No. 253216, 237113); Salt Lake City, alt. 1160 m., May, 1869, *Watson 674* (U. S. Nat. Herb. No. 49320); hills and mountains north of Salt Lake City, 9 June, 1905, *Rydberg 6003* (U. S. Nat. Herb.); Target Range, 23 May, 1908, *Clemens* (Mo. Bot. Gard. Herb.); dry gravelly "benches," near Salt Lake City, alt. 1400 m., 3 June, 1905, *Garrett 1095a* (U. S. Nat. Herb.), glabrous form; western slope of Wasatch Range, alt. 1340-1525 m., 17 May, 1913, *G. R. Hill Jr.* (Mo. Bot. Gard. Herb.); Alta, Aug., 1879, *M. E. Jones* (U. S. Nat. Herb.); Parley's Park, alt. 1830 m., June, 1869, *Watson 674* (U. S. Nat. Herb. No. 49315); Antelope Island, alt. 1210 m., June, 1869, *Watson 675* (U. S. Nat. Herb.); in rocky places, north of Ephraim, alt. 1650 m., 15 May, 1909, *Tidestrom 2073* (U. S. Nat. Herb.); Thistle, alt. 1615 m., 29 June, 1894, *M. E. Jones 5537k* (U. S. Nat. Herb.); Thistle Creek Junction, alt. 1370 m., 9 June, 1900 *Stokes* (U. S. Nat. Herb.); Simpson's Creek, 26 May, 1859, *H. Engelmann* (Mo. Bot. Gard. Herb.); Salina Cañon, alt. 2435 m., 15 June, 1894, *M. E. Jones 5441w* (U. S. Nat. Herb.); foot-hills near Glenwood, alt. 1645 m., 22 May, 1875, *Ward 81* (U. S. Nat. Herb. and Mo. Bot. Gard. Herb.); in gravel, Marysvale, alt. 2130 m., coll. of 1894, *M. E. Jones 5405l* (U. S. Nat. Herb.); rocky ridges, Diamond Valley, 16 May, 1902, *Goodding 818* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.), form with slightly hirtellous achenes.

Arizona: Grand Cañon, 12 July, 1892, *Wooton* (U. S. Nat. Herb.); Grand Cañon, alt. 1500-2100 m., 30 June, 1913, *Hitchcock 84½* (U. S. Nat. Herb.).

Nevada: Mormon Mountains, Lincoln Co., alt. 900-1825 m., July, 1906, *Kennedy & Goodding 106* (U. S. Nat. Herb.); Palisade, alt. 1525 m., 17 June, 1903, *Stokes* (U. S. Nat. Herb.); dry hills between Austin and Carter's Ranch, alt. 1950 m., 27 July, 1913, *Hitchcock 762* (U. S. Nat. Herb.); East Humboldt Mountains, alt. 2740 m., Aug., 1868, *Watson 674* (Gray

Herb.); Pilot Range, *Shockley* (Univ. Calif. Herb.); White Mountains near Sunland, alt. 2285 m., 25 June, 1912, *Heller 10505* (U. S. Nat. Herb. and Field Mus. Herb.); dry stony ground, Verdi, May, 1889, *Sonne 472* (Mo. Bot. Gard. Herb.); near Verdi, May, 1897, *Sonne* (Univ. Calif. Herb.); log railroad north of Verdi, alt. 1625 m., 24 June, 1913, *Heller 10878* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., Univ. Calif. Herb., and Field Mus. Herb.); Charleston Mountains, alt. 1525–1825 m., May–Oct., *Purpus 6103* (U. S. Nat. Herb.); summit between Austin and Birch Creek, Toiyabe Range, Lander Co., 31 July, 1913, *Kennedy 4588* (Univ. Calif. Herb.).

Oregon: on road east of Bly, alt. 1520 m., 1–5 Aug., 1896, *Coville & Leiberg 245* (U. S. Nat. Herb.).

California: Goose Lake Valley, July, 1895, *Mrs. R. M. Austin 560a* (U. S. Nat. Herb.); on dry rocks at Madeline Plains, Lassen Co., 3 June, 1897, *Applegate 867* (U. S. Nat. Herb.); Sierra Nevada Mountains, coll. of 1875, *Lemmon* (U. S. Nat. Herb.); northeastern California, coll. of 1879, *Lemmon 11* (Gray Herb.); Mono National Forest, alt. 2435 m., *King* (U. S. Nat. Herb.).

90. *S. stygius* Greene, *Leafl. Bot. Obs. & Crit.* 2: 21. 1909.

S. diffusus Greenm. *Monogr. Senecio*, I. Teil, 24. 1901, and *Engl. Bot. Jahrb.* 32: 20. 1902, name only, not L.

S. prolixus Greenm. *Ann. Mo. Bot. Gard.* 1: 264. 1914.

An herbaceous perennial, glabrous or white tomentulose in the axils of the leaves and at the base of the stem; stems solitary or several from a common base, 2 to 5 dm. high, terete, striate; radical and lower stem-leaves petiolate, lyrate-pinnatifid into oblong-cuneate coarsely dentate lobes which in well-developed specimens are separated by deep rounded sinuses, including the petiole 3 to 5 cm. long, 1 to 5 cm. broad, glabrous on both surfaces; inflorescence a loose corymbose cyme, 1 to 2.5 dm. in diameter; heads about 1 cm. high, radiate; involucre campanulate, sparingly calyculate, glabrous; bracts of the involucre usually 21, linear-lanceolate, 5 to 6 mm. long; ray-flowers about 13, ligules yellow; disk-flowers numerous, 50 to 60; achenes glabrous.

Distribution: along streams, western Arizona to south-eastern California.

Specimens examined:

Arizona: Grand Cañon of the Colorado River, May, 1884, *Lemmon* (U. S. Nat. Herb. No. 47166; fragments and photograph in Mo. Bot. Gard. Herb.); "Mohave region," April-May, 1884, *Lemmon 3130* (Gray Herb.), probably a duplicate of the preceding; Wickenburg, valley of the Hassayampa River, April, 1876, *Dr. E. Palmer 614* (Gray Herb., Phil. Acad. Nat. Sci. Herb., and Mo. Bot. Gard. Herb.); Pogump, 21 April, 1894, *M. E. Jones 5095n* (U. S. Nat. Herb.); without locality or date of collection, *Orcutt* (Univ. Calif. Herb. No. 131578).

Nevada: "Meadow Valley Wash, mile 16," alt. 1125 m., 28 April, 1904, *M. E. Jones* (U. S. Nat. Herb. No. 856543); without locality, coll. of 1891, *R. J. Jones* (Mo. Bot. Gard. Herb.).

California: Providence Mountains, 26 May, 1902, *Bran-degee* (Univ. Calif. Herb. No. 102018, and U. S. Nat. Herb. No. 735424).

91. *S. quercetorum* Greene, Leaf. Bot. Obs. & Crit. 2: 20. 1909.

S. Arizonicus Gray, Syn. Fl. N. Am. 1²: 392. 1884, and ed. 2, 1886, in part, as to plant of Rusby.

S. macropus Greenm. Monogr. Senecio, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. 32: 20. 1902; Ann. Mo. Bot. Gard. 1: 267. 1914.

A stout herbaceous perennial; stems erect, 7.5 to 10 dm. high, glabrous or white tomentulose in the axils of the leaves, striate, more or less purplish, often hollow; radical and lower stem-leaves petiolate, lyrate pinnatifid into few and relatively small unequal cuneate dentate to linear and entire lateral lobes and a large 5 to 8 cm.-long oblong-ovate coarsely dentate terminal segment, glabrous on both surfaces and, as well as the stem, more or less glaucous; upper stem-leaves sessile, pinnately lobed and conspicuously amplexicaul, gradually reduced towards the terminal open corymbose cyme; heads

about 1 cm. high, radiate; involucre campanulate, sparingly calyculate, glabrous; bracts of the involucre usually about 21, linear-lanceolate, 6.5 to 8 mm. long; disk-flowers numerous; achenes glabrous.

Distribution: known only from Arizona.

Specimens examined:

Arizona: "Oak Creek," 23 June, 1883, *Rusby 672* (U. S. Nat. Herb. and Phil. Acad. Nat. Sci. Herb.; fragments and photographs in Mo. Bot. Gard. Herb.), TYPE; without locality, coll. of 1883, *Rusby 175* (Gray Herb.), type of *S. macropus* Greenm.

92. *S. franciscanus* Greene, *Pittonia* 2: 19. 1889; Greenm. Monogr. Senecio, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. 32: 20. 1902.

A low herbaceous subcespitose perennial, 1 dm. or less high from an ascending or suberect rootstock, at first somewhat tomentulose, later glabrate, more or less tinged with purple; leaves mostly pinnately divided, including the petiole 1-5 cm. long, .5 to 1.5 cm. broad, thickish in texture; the lowermost leaves sometimes undivided and subrotund, about 1 cm. long and broad, crenate-dentate; heads solitary or few, 10 to 12 mm. high, radiate; involucre campanulate, sparingly calyculate; bracts of the involucre 13 to 21, linear-lanceolate, 7 to 10 mm. long, tomentulose at the base, glabrous and purplish above; rays yellow; disk-flowers numerous; achenes glabrous.

Distribution: known only from the high mountains of northern Arizona.

Specimens examined:

Arizona: volcanic rocky soil near the summit of San Francisco Mountains, 10 July, 1889, *Greene* (U. S. Nat. Herb.), TYPE; summit of Mt. Agassiz, in volcanic scoria, Aug., 1884, *Lemmon* (Gray Herb. and U. S. Nat. Herb.); peak of San Francisco Mountains, alt. 3050 m., 30 Aug., 1884, *M. E. Jones 15* (Gray Herb.); San Francisco Mountains, 23 Aug., 1889, *Knowlton 95* (U. S. Nat. Herb.); Humphrey's Peak, San Francisco Mountains, alt. 2740-3050 m., 7-10 Aug., 1898, *Mac-*

Dougal 401 (Gray Herb., Phil. Acad. Nat. Sci. Herb., U. S. Nat. Herb., and Univ. Ariz. Herb.); near Flagstaff, May-Oct., 1900, *Purpus* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.).

93. **S. Breweri** Davy, *Erythea* 3: 116. 1895; Greene, *Fl. Franciscana*, 471. 1897; Greenm. Monogr. *Senecio*, I. Teil, 24. 1902, and in *Engl. Bot. Jahrb.* 32: 20. 1902.

S. eurycephalus Gray, *Syn. Fl. N. Am.* 1²: 392. 1884, and ed. 2, 1886, in part; Jepson, *Fl. West. Mid. Calif.* 512. 1901, in part; Hall, *Univ. Calif. Pub. Bot.* 3: 233. 1907, in part, not Torr. & Gray.

An herbaceous perennial, glabrous throughout; stems erect, 4 to 8 dm. high, striate or furrowed; radical and lower stem-leaves petiolate, including the petiole 5 to 30 cm. long, 1.5 to 9 cm. broad, lyrate pinnatifid with obovate-cuneate coarsely and unequally toothed to sublobate segments, frequently bearing intermediate smaller lobes; the terminal segment oblong-ovate, much larger than the lateral ones; upper stem-leaves sessile and more or less amplexicaul, pinnatisect with slender unequally laciniate-lobed to entire segments, often much attenuated; inflorescence a terminal loose corymbose cyme; heads 12 to 15 mm. high, radiate; involucre campanulate, sparingly calyculate with short bracteoles; bracts of the involucre 15 to 17, lanceolate, 8 to 10 mm. long, 1.5 to 3 mm. broad, thickish in texture along the median line but with scarious margins; ray-flowers 8 to 10, rays yellow, conspicuous, 10 to 15 mm. long, 2.5 to 4 mm. broad; disk-flowers 45 to 60; mature achenes strongly ribbed, glabrous, about 5 mm. long.

Distribution: central western California and southward.

Specimens examined:

California: Atascadero, Geol. Surv. Calif., coll. of 1860-62, *Brewer 512* (Gray Herb. and U. S. Nat. Herb.), TYPE; Mt. Diablo, 30 April, 1868, *Brewer 538* (Gray Herb. and U. S. Nat. Herb.); Lemmon's Ranch, Cholame, June, 1887, *Lemmon 4585* (Gray Herb.); near Paso Robles, 23 April, 1899, *J. H. Barber* (Gray Herb.); Paso Robles, April, 1907, *Cobb* (U. S. Nat. Herb.); back of San Mateo on the Half Moon Bay road,

23 May, 1907, *Heller 8565* (Phil. Acad. Nat. Sci. Herb., Mo. Bot. Gard. Herb., U. S. Nat. Herb., and C. C. Deam Herb.); foothills near Stanford University, Santa Clara Co., May, 1902, *C. F. Baker 1711* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.); Stanford University, 8 May, 1902, *Abrams 2432* (Mo. Bot. Gard. Herb.); Black Mountain, near Stanford University, 19 May, 1895, *Rutter 13* (U. S. Nat. Herb.); Stanford University, June, 1903, *Elmer 4418* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Blue Mountain, Greenhorn Range, Kern Co., 2-10 June, 1904, *Hall & Babcock 5000* (Gray Herb.); Tehachapi Valley, Kern Co., alt. 1200 m., 25 June, 1891, *Coville & Funston 1122* (U. S. Nat. Herb.); in Owens Valley and at Fort Tejon, Geol. Surv. Calif., 1862-64, *Horn* (U. S. Nat. Herb. No. 323752); hillsides at Bitterwater, San Benito Co., May, 1915, *Hall 9912* (Mo. Bot. Gard. Herb.); Carisa Plain, McDonald's Ranch, 3 May, 1896, *Eastwood* (Gray Herb. and U. S. Nat. Herb.); hillsides among scrub oak, Gorman Station, Los Angeles Co., *Davidson* (Gray Herb.); without locality, *Coulter 336* (Kew Herb.).

Var. *contractus* Greenm. var. nov.

Stem about 8 dm. high; leaf-characters similar to the species; inflorescence strongly contracted into a round-topped cyme; heads somewhat smaller than in typical forms of the species.

Distribution: known only from the type locality.

Specimen examined:

California: San Rafael Mountain, *John Spence* (Gray Herb.), TYPE.

94. *S. eurycephalus* Torr. & Gray, ex Gray in Mem. Am. Acad. [Pl. Fendl.] 4: 109. 1849; Pac. Rail. Rept. 4: 111. 1856, excl. var. *major*; Bot. Calif. 1: 411. 1876; Syn. Fl. N. Am. 12: 392. 1884, and ed. 2, 1886; Greene, Fl. Franciscana, 471. 1897; Greenm. Monogr. *Senecio*, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. 32: 20. 1902; Hall, Univ. Calif. Pub. Bot. 3: 233. 1907, excl. synonymy and plant of Barber; Jepson, Fl. West. Mid. Calif. 512. 1901, in part, and ed. 2, 428. 1911.

S. Tidestromii Greene, Fl. Franciscana, 472. 1897.

An herbaceous perennial, at first tomentose or at least tomentulose, later more or less glabrate; stems one to many from a perennial base, erect or nearly so, 3 to 5 dm. high, striate; radical and lower stem-leaves petiolate, including the petiole 3 to 18 cm. long, 1 to 3 cm. broad, sublyrately pinnatifid with rather remote oblong-cuneate coarsely and unequally toothed lateral divisions and somewhat confluent terminal segments; uppermost leaves pinnatifid, sessile; inflorescence a terminal loose subcorymbose cyme; heads relatively large, 12 to 18 mm. high, radiate; involucre campanulate, sparingly calyculate; bracts of the involucre usually 21, narrowly lanceolate, about 1 cm. long, tomentulose or glabrous; ray-flowers 10 to 12, rays yellow; disk-flowers numerous; mature achenes about 5 mm. long, conspicuously ribbed, glabrous.

Distribution: usually in moist ground in the Coast Ranges of central California to southern Oregon.

Specimens examined:

California: without definite locality, *Fremont* (Gray Herb.), TYPE; without definite locality, *Hartweg* (Gray Herb.); on alkaline soil at the Geysers, Sonoma Co., 26 April, 1864, *Bolander 3963* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.); dry plains in the oak belt, Lake Co., 8 June, 1916, *Heller 12384* (Mo. Bot. Gard. Herb.); near Pit River Ferry, Shasta Co., 15-28 May, 1897, alt. 210-275 m., *H. E. Brown 234½* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Knoxville, Napa Co., 8 May, 1903, *C. F. Baker 3080* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.); in gravel and sand, at the river bridge near Redding, Shasta Co., 26 May, 1905, *Heller 7871* (Phil. Acad. Nat. Sci. Herb., Mo. Bot. Gard. Herb., U. S. Nat. Herb., and C. C. Deam Herb.); lava beds of northeastern Shasta Co., June, 1903, alt. 1220 m., *Hall & Babcock 4232* (Gray Herb.); Red Bluff, Tehama Co., 6 April, 1913, *Wootton* (U. S. Nat. Herb.).

Oregon: dry soil near Sprague River, 16 Aug., 1901, *Cusick 2763* (Gray Herb., U. S. Nat. Herb., and Mo. Bot. Gard. Herb.).

95. *S. Austinae* Greene, Bull. Calif. Acad. Sci. 1: 93. 1885; Greenm. Monogr. Senecio, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. 32: 20. 1902.

S. Neo-Mexicanus Gray, Syn. Fl. N. Am. 1²: 454. 1885, not Gray, Proc. Am. Acad. 19: 55. 1883.

An herbaceous perennial; stem simple, erect, 3 to 4 dm. high, nearly naked above, striate, glabrous; lower leaves petiolate, oblong-ob lanceolate, 2 to 8 cm. long, .5 to 1.5 cm. broad, sharply and unequally callous-mucronate-dentate, thickish in texture, inconspicuously tomentulose to glabrous; uppermost leaves reduced to entire bracts; inflorescence a terminal few-headed corymbose cyme; heads 10 to 12 mm. high, radiate; involucre campanulate, sparingly calyculate; bracts of the involucre about 21, linear-lanceolate, acute, 7 to 8 mm. long, glabrous; ray-flowers 8 to 10, rays light yellow; disk-flowers numerous; achenes glabrous.

Distribution: northeastern California.

Specimens examined:

California: Alturas, Modoc Co., July, 1884, *Mrs. R. M. Austin* (Greene Herb., Univ. of Notre Dame, and Gray Herb.). The specimen in the Gray Herbarium, although incompletely labeled, is taken to be a part of the original material on which the species was founded.

This species is closely related to *S. eurycephalus* Torr. & Gray, but it differs in having the upper portion of the stem nearly naked, and in having merely laciniate-toothed leaves without the deep rounded sinuses which are characteristic of the Torrey and Gray species.

96. *S. ionophyllus* Greene, Pittonia 2: 20. 1889; Fl. Franciscana, 472. 1897; Greenm. Monogr. Senecio, I. Teil, 24. 1901, and in Engl. Bot. Jahrb. 32: 20. 1902; Hall, Univ. Calif. Pub. Bot. 3: 231. 1907.

An herbaceous perennial; stems one to several from a common base, 2 to 3.5 dm. high, simple or branched, leafy at the base, sparingly leafy above; lower leaves including the long slender petiole 2.5 to 8 cm. long, .5 to 2 cm. broad, obovate-

cuneate and few-toothed to lyrate pinnatifid, thickish in texture, glabrous or at first tomentulose and more or less glabrate and, as well as the stem, often purplish; uppermost leaves reduced to sessile lanceolate entire bracts; heads 1 to 3, relatively large, 1.5 to 2 cm. high, radiate; involucre campanulate, calyculate, glabrous or tomentulose at the base; bracts of the involucre 13 to 21, narrowly lanceolate; rays light yellow; disk-flowers numerous; mature achenes 5 mm. long, strongly ribbed, glabrous.

Distribution: southern California.

Specimens examined:

California: precipitous sides of Bear Creek, above Corkscrew Falls, San Bernardino Mountains, 22 June, 1895, *Parish 3604* (Gray Herb.); dry woods, San Bernardino Mountains, alt. 1675 m., Aug., 1904, *Williamson* (Phil. Acad. Nat. Sci. Herb. and C. S. Williamson Herb.); Wilson's Peak, Los Angeles Co., coll. of 1893, *Davidson* (Greene Herb., Univ. of Notre Dame); hillside, under pines, South Fork of Santa Ana River, alt. 1920 m., 27 June, 1906, *Grinnell 256* (U. S. Nat. Herb.); Swartout Cañon, desert slopes of the San Gabriel Mountains, 5 July, 1908, *Abrams & McGregor 647* (U. S. Nat. Herb.).

Var. *sparsilobatus* (Parish) Hall, Univ. Calif. Pub. Bot. 3: 232. 1907.

S. sparsilobatus Parish, Bot. Gaz. 38: 462. 1904.

S. intrepidus Greenm. in herb.

Stems one to several from a stout or stoutish rootstock, 1 to 2 dm. high; leaves chiefly basal, obovate-cuneate and subentire to lyrate pinnatifid into few rounded or obtusely dentate lateral lobes, including the petiole 1.5 to 5 cm. long, .5 to 1.5 cm. broad, thick and firm in texture; heads few, smaller than in the species, 1 to 1.5 cm. high.

Specimens examined:

California: trail to South Fork of Santa Ana River via Barton Falls, alt. 2285 m., 28 Aug., 1905, *Charlotte N. Wilder 244* (U. S. Nat. Herb.); Lytle Creek Cañon, San Antonio Mountains, alt. 1830 m., 1-3 June, 1900, *Hall 1456* (Field Mus.

Herb. and Gray Herb.; photograph in Mo. Bot. Gard. Herb.);
Upper Santa Ana Cañon, Transition Zone, alt. 2285-2430 m.,
26 July, 1906, *Hall 7575* (Mo. Bot. Gard. Herb.).

(To be continued.)

EXPLANATION OF PLATE

PLATE 4

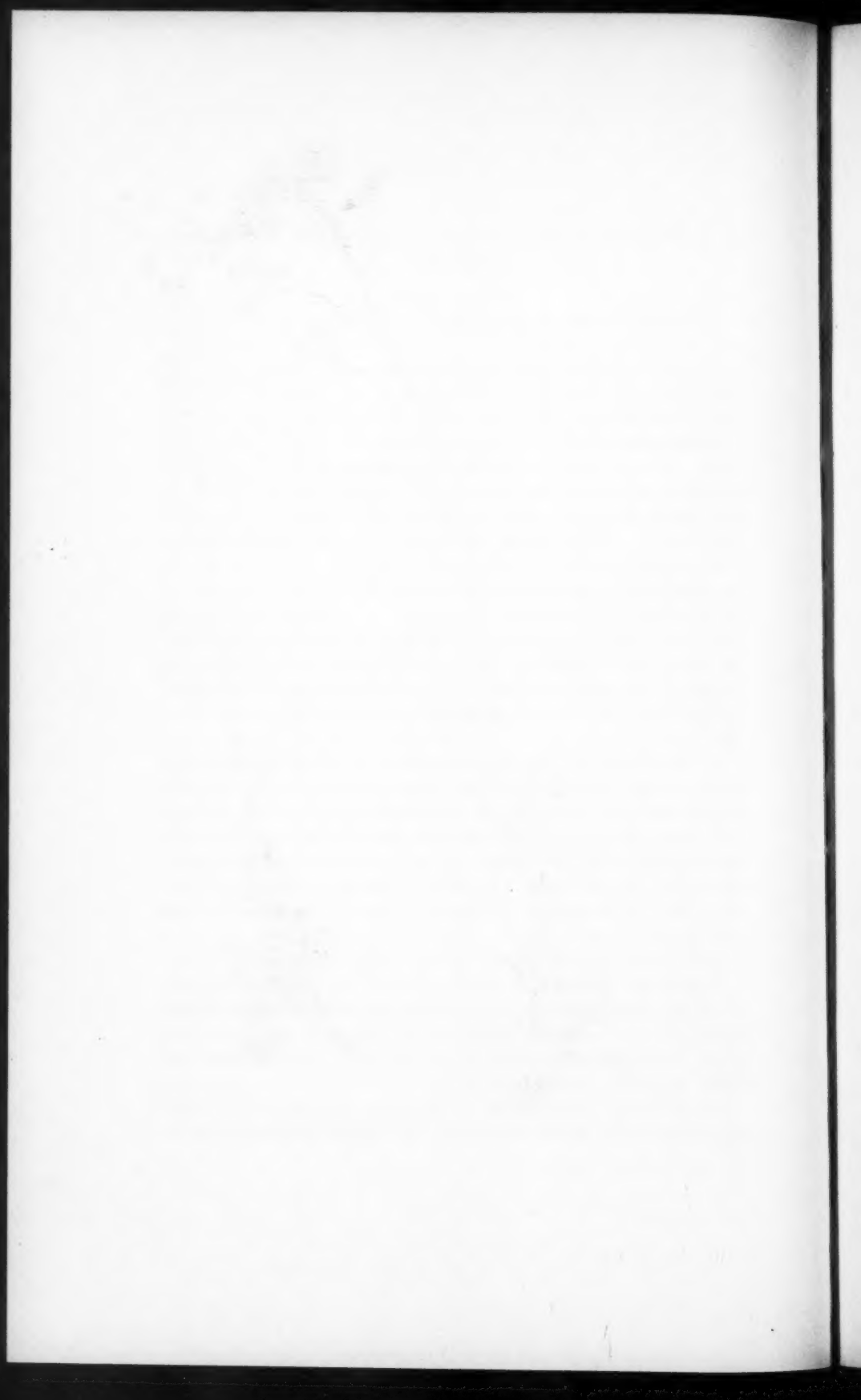
Senecio lynceus Greene
United States

From Lemmon's Nos. 3263, 3263½ in the Gray Herbarium of Harvard University.





GREENMAN — MONOGRAPH OF SENECIO



A SPURLESS VARIETY OF *HABENARIA PSYCODES*
(L.) SW.

MARY M. BRYAN

Formerly Graduate Student in the Henry Shaw School of Botany of
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For several years a certain colony of orchids has been observed near Bay View, Michigan, by Dr. Chas. H. Swift of the University of Chicago, which, on account of the marked variation in the flower and the apparent constancy of one form, has prompted a critical examination of all available material of related species, as well as a review of the literature pertaining to the general subject of variation in the genus *Habenaria*. Of the three specimens from the above locality, which were secured by Dr. Swift and now preserved in the herbarium of the Missouri Botanical Garden, one accords in every detail with typical specimens of *Habenaria psycodes* (L.) Sw.; that is to say, the labellum is distinctly 3-lobed, and the lobes are fringed to less than one-third their length, the terminal lobe being somewhat emarginate; the petals are more or less denticulate, and the spur about equals the ovary (pl. 5, fig. A).

A somewhat intermediate condition as to floral structure is shown by the second of the three specimens (fig. B), the variations being as follows: the labellum is broadly emarginate and wedge-shaped in outline, and the lateral lobes are entirely wanting; the petals are entire, and the spur is considerably shorter than the ovary. Moreover, the flowers of the spike are extremely variable in respect to margin of lip and length of spur.

This form may be designated as:

Habenaria psycodes (L.) Sw., formal var. **varians**, n. var.

Petalis lateralibus integris; labello cuneato late emarginato haud trilobato; calcarum quam ovario brevius. — Near Bay View, Michigan, July, 1913, Dr. Charles H. Swift (Mo. Bot. Gard. Herb. No. 710165), TYPE.

An extreme variation of the type is shown by the third specimen. This differs from *H. psycodes* in having an undi-

vided, entire, and slightly saccate lip, entire petals, and by the complete absence of a spur (fig. C). This variety has maintained itself through several years, and seems deserving of record, as follows:

***Habenaria psycodes* (L.) Sw., var. *ecalcarata*, n. var.**

Caulis 4-5 dm. altus, 3-4-foliatus; foliis inferioribus lanceolatis vel oblanceolatis, 1.5-2 dm. longis, 1.3-4.5 cm. latis, superioribus gradatim reductis bracteiformibus; racemo circiter 12 cm. longo, plus minusve secundo, bracteis linearilanceolatis floribus plerumque longioribus; floribus numerosis ecalcaratis; sepalis oblongo-ellipticis ca. 6 mm. longis, 2 mm. latis, obtusis; petalis lateralibus oblongis ad basim obliquis sepalis paulo brevioribus; labello oblongo indiviso integro parum saccato, marginibus non nihil insolutis; ovario 8-10 mm. longo.

Stem 4-5 dm. high, 3-4-foliate; lower leaves lanceolate or oblanceolate, 1.5-2 dm. long, 1.3-4.5 cm. broad, the upper gradually reduced, passing into linear-lanceolate bracts; inflorescence about 12 cm. long, more or less secund; bracts linear-lanceolate, mostly longer than the flowers; flowers numerous, ecalcarate; sepals oblong-elliptic, about 6 mm. long, 2 mm. wide, obtusish; lateral petals oblong-oblique at base, a little shorter than the sepals; lip oblong, undivided, entire, slightly saccate with somewhat infolded margins; ovary 8-10 mm. long.—Near Bay View, Michigan, July, 1913, *Dr. Charles H. Swift* (Mo. Bot. Gard. Herb. No. 701166), TYPE.

The literature relating to the subject shows a number of parallel cases of variation in other species of *Habenaria*. Ogden¹ records a variety of *H. ciliaris* in which the lip is either entire or imperfectly fringed and the spurs are mostly lacking. About the same time Mr. Henry G. Jesup² described and illustrated an interesting variation in *H. fimbriata* in which the long and prominent spur of the species is lacking and the sepals and petals are entire and all alike except in two or three flowers on one of the spikes, where there was a slight suggestion of a fringed lip. In 'Pflanzen-Teratologie,'

¹ Bull. Torr. Bot. Club 20: 38. 1893.

² Bot. Gaz. 18: 189. 1893.

Vol. II, Dudley writes that in many specimens of *H. hyperborea* flowers have been found without spurs and with the labellum like that of *H. dilatata*.

The question arises: Are our new varieties products of spontaneous variation (mutability), or have they been evolved from the ever-present fluctuating variations which a species offers as material for natural selection to work on? According to the latter and more conservative hypothesis the extreme variation, namely, var. *ecalcarata*, fig. C, owes its existence to the "gradual summation of small deviations in one direction, through succeeding generations," the intermediate formal variety *varians*, fig. B, indicating a transitional form in the series. These small deviations (fluctuating variations) being useful, according to the theory, offer the essential material which natural selection has gradually accumulated in one direction, resulting in an extreme type like our variety *ecalcarata*. This slow formation of species would necessarily require a long period of time. The existence of intermediate forms, like our formal variety *varians*, would seem to furnish proof for this conservative belief in the slow formation of species.

On the other hand, variety *ecalcarata* may be regarded as a probable mutant from *H. psycodes*; and the formal variety *varians* may then be a hybrid between the species and the extreme variety. An experimental proof could be attempted in this case. In favor of this view it may be said that the sudden origin of new forms other than by a series of transitional stages is in accordance with the facts of plant breeding. De Vries derives the doctrine that variability may be increased by selection; one of the chief objects of his book, he says, is "to try to show that ordinary or fluctuating variability does not provide material for the origin of new species." He speaks of the "illusion of an increase in variability." The existence of intermediate forms, according to the conservative view, is usually pointed out as filling the gaps between the discontinuous series that species form. De Vries says, however, that these are not transitional forms, but are independent types, which he calls elementary species

(mutations). If, as a result of experimentation, we are forced to deny the existence of transitional forms as such, then that fact along with the fact of the existence of apparently useless characters suffices, according to him, to beset the selection theory with serious difficulties.

Accordingly, a third possible suggestion might be offered, namely, to consider both varieties as elementary species, simultaneous mutants from *H. psycodes*. Since no new characters have been added, they would be what De Vries calls retrogressive; he even states that "there are possibly more species on the face of the earth at present that have arisen on retrogressive than on progressive lines—just as it is held that the monocotyledons have arisen from the dicotyledons by the loss of a whole series of characters."

In his paper on 'Die Bedeutung sprunghafter Blütenvariationen für die Orchideenflora Südbrasieliens,' Porsch tells how certain species of orchids brought over to Germany by Prof. Wettstein from southern Brazil entered on a sudden period of mutation, and that under his very eyes he saw the origin of several elementary species. He attributed the induction of the period of mutability to the external factors of a changed condition of nourishment. He states that although he does not believe that mutation is the only way by which new forms may originate, yet he thoroughly believes in spontaneous variability as the species-forming factor in the orchid family. It may not be impossible that the species *H. psycodes* is in a period of mutability; experimental studies alone could decide.

In his 'Pflanzen-Teratologie' Penzig mentions three spurless varieties of *H. ciliaris*, *H. fimbriata*, and *H. hyperborea*, respectively, as cases of peloria. Examples of pelorism among orchids seem to be not uncommon. Peloria is a term first used by Linnaeus to describe the five-spurred flowers of *Linaria vulgaris*, newly discovered at that time. The name is derived from the Greek word for monster. It is now applied by botanists to all flowers which pass from irregularity to regularity. The lip of an orchid is really a petal which has become irregular in form, and in the two genera

Orchis and *Habenaria* the lip is prolonged backwards into a spur, which adds further to the irregularity. Through the loss of a spur or of other irregularities, the flower may assume a regular form. Cases have been recorded also of three-spurred orchids. Hill¹ describes *H. lacera* var. as having three spurs and two lips, and one of the lips again dividing as if to maintain the tri-formity. Two columns were also present.

Cases of false peloria have also been found in which two extra spurs were produced by the lateral sepals and not, as in cases of true peloria, by the lateral petals. Abnormalities such as these are especially interesting in the case of the orchids. The pelorias consist chiefly either in the loss of the spur, or else in an increase in the number of spurs to three. In either case this tends to make the flowers pass from zygomorphy to actinomorphy, and the latter condition is probably more primitive than the present irregular form. Regularity must be a latent yet heritable character in orchids, and the loss of it in this extremely complex and highly differentiated family is only apparent, since it shows a not uncommon tendency to return to its full activity in these peloric forms. Our concern is whether this latent character has returned to activity suddenly, or whether by a slow and gradual recovery of the former features. Pelorism is a phenomenon where the capacity to form irregular flowers has been reduced to a latent or inactive state. Conditions of nutrition are thought to be the external cause in inducing the appearance or non-appearance of the monstrosity.

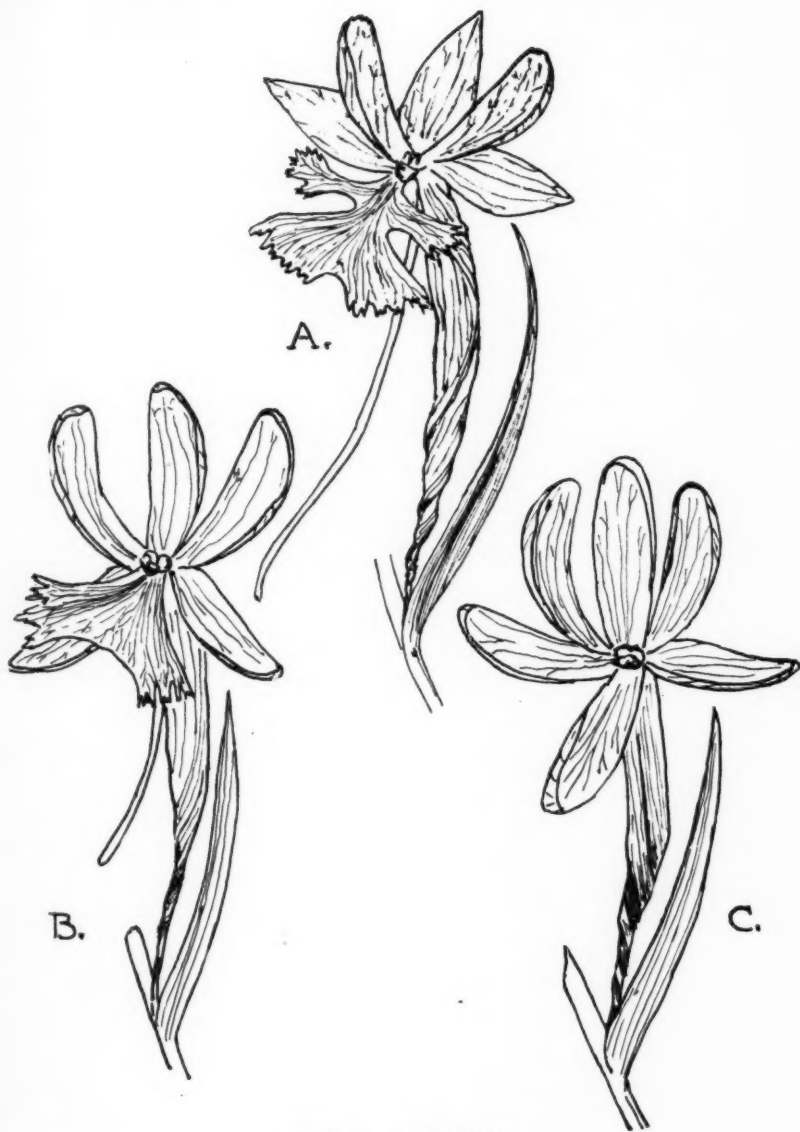
Hundreds of steps have probably been necessary in the evolution of the orchid family. The variety with which we are now concerned, therefore, and others, may be considered as a reversion toward an ancestral condition on the part of the species exhibiting it—a reversion which seems an offset to the extreme specialization to which orthogenesis or adaptation has led the family. Monstrosities as commonly understood are now generally regarded as visible manifestations of a heritable, though for the most part latent, potentiality, and are retrogressive phenomena.

¹ Bot. Gaz. 15: 145. 1890.

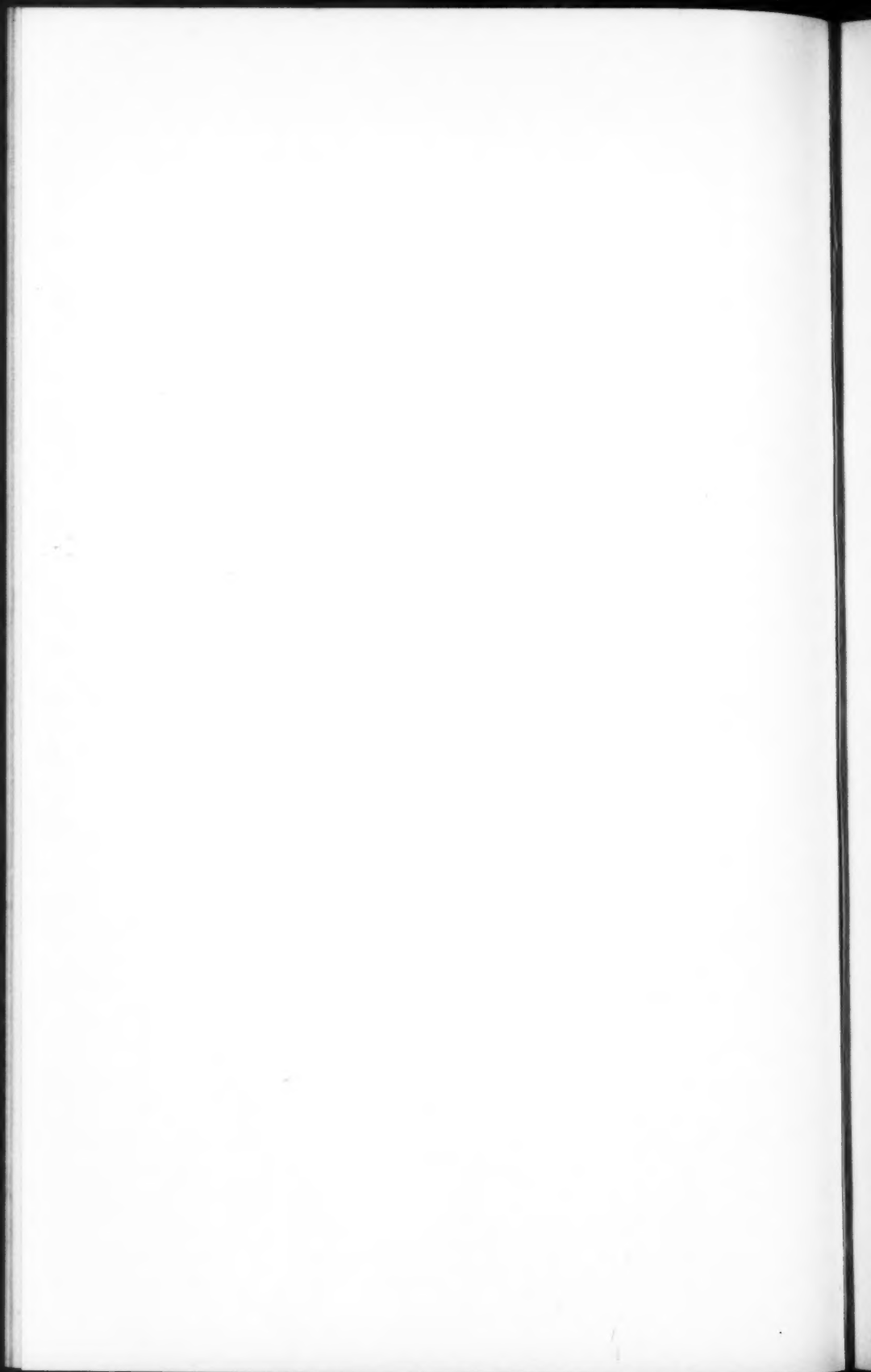
EXPLANATION OF PLATE

PLATE 5

- Fig. A. *Habenaria psycodes* (L.) Sw.
Fig. B. *Habenaria psycodes* (L.) Sw., formal var. *varians*, n. var.
Fig. C. *Habenaria psycodes* (L.) Sw., var. *eculcarata*, n. var.



BRYAN—HABENARIA



A SYSTEMATIC STUDY OF THE NORTH AMERICAN GENUS TRILLIUM, ITS VARIABILITY, AND ITS RELATION TO PARIS AND MEDEOLA

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INTRODUCTION

Trillium is a genus in which remarkable uniformity in general appearance and structure is combined with great variability in certain organs from species to species. This variability is of such a nature that it is often difficult to delimit the species accurately according to present knowledge. While the range of variation, in leaf characters, for example, is so slight in the genus that a single leaf can in nearly all cases be recognized at sight as belonging to *Trillium*, yet in many cases it would be quite impossible to determine with certainty the species.

The present paper may therefore be regarded as a conspectus of the North American species of *Trillium*—thirty-one of which, with nine varieties, are recognized—without an attempt to delimit in many cases the exact boundaries of individual species. This can only be done satisfactorily after further extensive field studies of the range of variation in a number of the species.

Trillium is of particular interest from another point of view. A number of its species have long been known to give rise to striking variations, such as double flowers, extra leaf whorls, increase in number of parts in a whorl, etc. The references to such cases are very scattered in the literature, but in the second part of this paper an attempt is made to bring them together. While it is quite certain that there are omissions, yet it is hoped that all the more important records have been included. The remarkable variations of *T. grandiflorum* have been most extensively studied, but cases in which extra whorls of leaves occur are perhaps of greater phylogenetic interest. Instances in which a double flower continues to be produced from the same rootstock year

after year indicate that such a rootstock developed from a seed in which a definite germinal change had taken place. The occurrence of double flowers, which was formerly supposed to be a result of cultivation, is now known as a variation in many wild species.

Unless otherwise mentioned, the specimens examined are from the herbarium of the Missouri Botanical Garden where most of the work was done.

KEY TO MAP

- | | |
|---|--|
| 1. <i>T. discolor</i> Wray | 16a. <i>T. erectum</i> var. <i>album</i> (Michx.) Pursh |
| 2. <i>T. stamineum</i> Harb. | 16b. <i>T. erectum</i> var. <i>viridiflorum</i> Hook. |
| 3. <i>T. decumbens</i> Harb. | 17. <i>T. Vaseyi</i> Harb. |
| 4. <i>T. sessile</i> L. | 18. <i>T. Rugelii</i> Rendle |
| 5. <i>T. Underwoodii</i> Small | 19. <i>T. simile</i> Gleason |
| 6. <i>T. Hugerii</i> Small | 20. <i>T. declinatum</i> (Gray) Gleason |
| 7. <i>T. luteum</i> (Muhl.) Harb. | 21. <i>T. cernuum</i> L. |
| 7a. <i>T. luteum</i> var. <i>latipetalum</i> Gates, n. var. | 22. <i>T. undulatum</i> Willd. |
| 8. <i>T. viridescens</i> Nutt. | 23. <i>T. Scouleri</i> Rydb. |
| 9. <i>T. viride</i> Beck | 24. <i>T. grandiflorum</i> (Michx.) Salisb. |
| 10. <i>T. Ludovicianum</i> Harb. | 24a. <i>T. grandiflorum</i> var. <i>trans. variegatum</i> Smith |
| 11. <i>T. lanceolatum</i> Boykin ex Wats. | 24b. <i>T. grandiflorum</i> var. <i>trans. parvum</i> Gates, n. var. |
| 11a. <i>T. lanceolatum</i> var. <i>rectistamineum</i> Gates, n. var. | 25. <i>T. ovatum</i> Pursh |
| 12. <i>T. recurvatum</i> Beck | 25a. <i>T. ovatum</i> trans. var. <i>stenosepalum</i> Gates, n. var. |
| 13. <i>T. petiolatum</i> Pursh | 26. <i>T. nivale</i> Riddell |
| 14. <i>T. giganteum</i> (Hook. & Arn.) Heller | 27. <i>T. rivale</i> Wats. |
| 14a. <i>T. giganteum</i> var. <i>chloropetalum</i> (Torr.) Gates, comb. nov. | 28. <i>T. Catesbaei</i> Ell. |
| 14b. <i>T. giganteum</i> var. <i>angustipetalum</i> (Torr.) Gates, comb. nov. | 29. <i>T. affine</i> Rendle |
| 15. <i>T. pusillum</i> Michx. | 30. <i>T. venosum</i> Gates, n. sp. |
| 16. <i>T. erectum</i> L. | 31. <i>T. obovatum</i> Pursh |

TRILLIUM L.

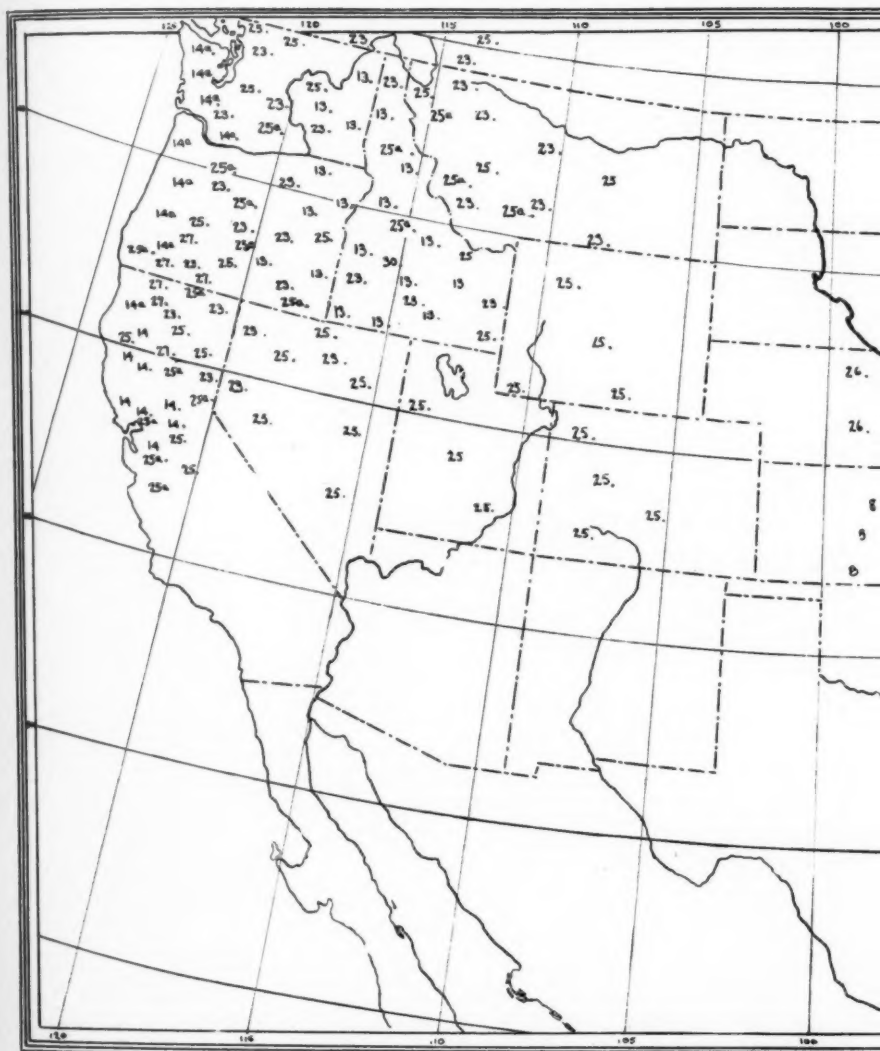
1. *Trillium discolor* Wray, in Curt. Bot. Mag. pl. 3097. 1831.

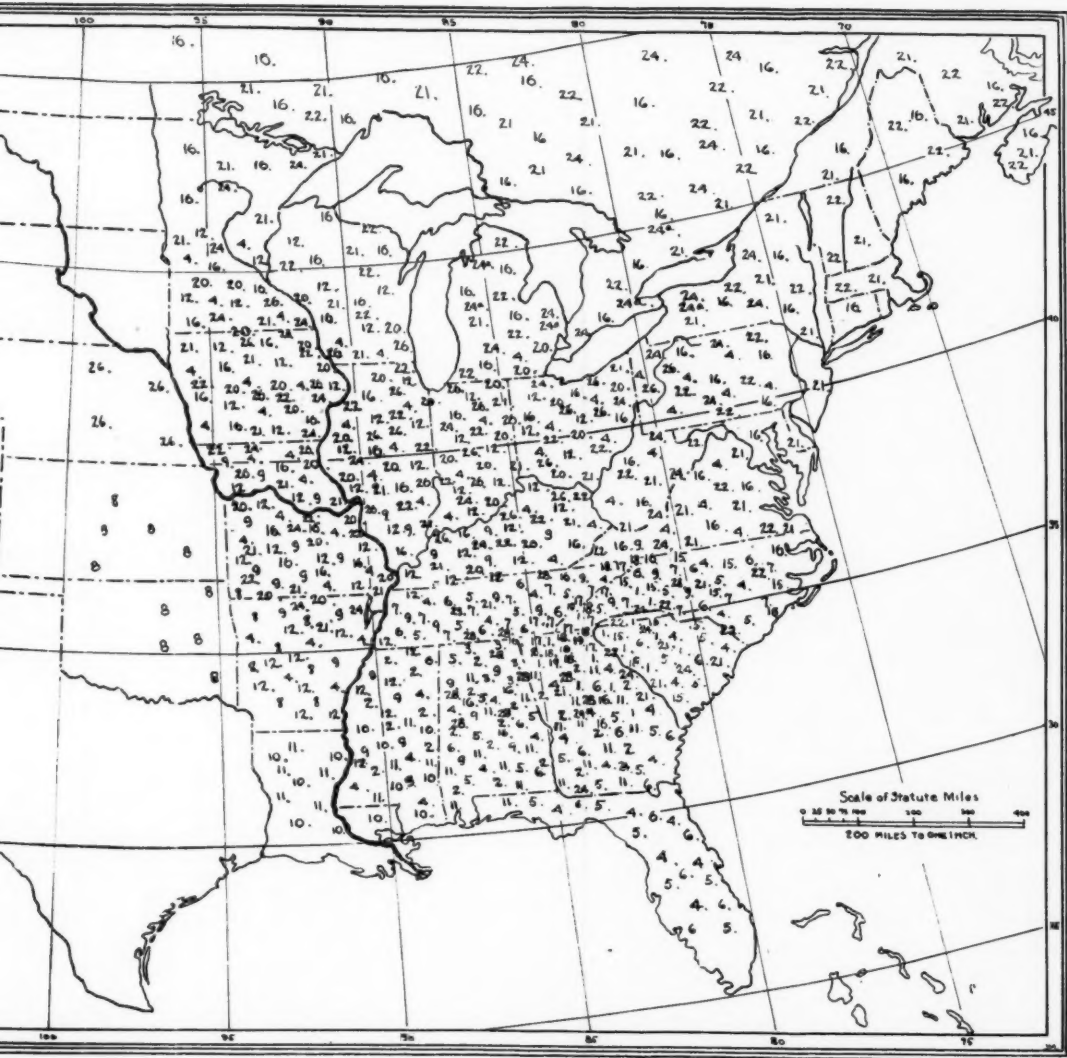
T. sessile var. *Wrayi*. Wats. Proc. Am. Acad. 14: 273. 1879.

This peculiar species is mainly distinguished from the other species of the *T. sessile* group by its very obtuse, broadly spatulate petals (one usually apiculate), which are pale sulphur-yellow inclining to green.

In pine woods, South Carolina, North Carolina, and Georgia. Rare.

2. *T. stamineum* Harb. Biltm. Bot. Studies 1: 23. 1901.





Map showing distribution of species of *Trillium*.

Nearest *T. sessile* but easily recognized by its pubescent stem, widely spreading, twisted petals, unpleasant odor, larger stamens, and very short filaments.

In rocky woods, Georgia, Alabama, and Mississippi.

3. *T. decumbens* Harb. Biltm. Bot. Studies 1: 158. 1902.

This species agrees with *T. stamineum* in having a pubescent stem, twisted petals, and very short filaments, and differs from it chiefly in having erect petals, decumbent stem, flowers not fetid, stamens only one-fourth the length of the petals, stigma stout, and a marked prolongation of the anther connective. The last feature occurs in no other known species of *Trillium* except as an occasional variation, but is found more highly developed as a generic character in the genus *Paris*.

In rocky woods, northeastern Alabama.

4. *T. sessile* L. Sp. Pl. 340. 1753; Curt. Bot. Mag. pl. 40. 1790; Lodd. Bot. Cab. 9: pl. 875. 1824; Fl. Serres 22: pl. 2311. 1877; Redouté, Les Liliacées 3: pl. 133. 1807; Lamarek, Encyc. Meth. 8: 102. 1808; Illustr. Gen. Tab. 2: pl. 267, fig. 1. 1823.

Solanum Virginianum tryphyllon, tripetalo flore atropurpureo, in foliorum sinu absque pediculo sessili, Pluk. Alm. Bot. 352. 1696; Phytogr. pl. 111, fig. 6. 1691.

Solanum triphyllon Catesb. Nat. Hist. Car. 1: 50. pl. 50. 1754.

In woods, Pennsylvania to Minnesota, south to Florida, Mississippi, and Arkansas.

5. *T. Underwoodii* Small, Bull. Torr. Bot. Club 24: 172. 1897.

This species is distinguished from *T. sessile* chiefly by its larger sepals, narrowly oblanceolate, longer petals, which are also longer relatively to the length of the sepals, and by its longer anthers.

In woods and fields, North Carolina to Tennessee, south to Florida and Alabama.

6. **T. Hugerii** Small, Fl. Southeastern U. S. 277. 1903.

This plant differs from *T. Underwoodii* in having leaves suborbicular to broadly ovate, abruptly obtuse-pointed, petals oblong-lanceolate to spatulate, and anthers not subsessile.

In rich woods, North Carolina and Tennessee to Florida.

7. **T. luteum** (Muhl.) Harb. Biltm. Bot. Studies 1: 21. 1901.

Plate 7, fig. 2.

T. sessile var. *luteum* Muhl. Cat. 38. 1813.

This is distinguished from *T. Underwoodii* by the yellow color of the petals, ovary, filaments, and anthers; otherwise it is remarkably similar to that species. Intergrading forms which are probably hybrids occur with petals ranging from dark purple to greenish. Forms also occur with yellow petals and purple anthers, or the petals may be purple and the anthers yellow, or only the connectives of the anthers may be purple. These are perhaps independent Mendelian differences which are constantly being interchanged by crossing in the population. The petals also vary in shape, and there are at least two distinct races in this regard, as indicated by the specimens examined. The petals of the following specimens are rather narrowly lanceolate, 5.6 cm. long, 1 cm. wide, with anthers 2 mm. wide.

Knoxville, Tenn., April, 1898, *A. Ruth* 150, four specimens; same locality, April, 1897, *A. Ruth*, two specimens, cotype.

In woods and along streams, North Carolina and Tennessee. The species is said to occur abundantly near Kingston, Tennessee.¹

7a. Var. **latipetalum** Gates, n. var.

Plate 7, fig. 3.

The following specimens differ from the species in having petals which are oblong-obovate, 3-4.4 cm. in length, 1.4-2 cm. wide, and purple anthers scarcely exceeding 1 mm. in width.

Clemson College, Oconee Co., S. C., April 7, 1906, *H. D. House* 1789, two specimens.

Two other specimens on the above sheets represent yet a third type, having leaves broadly oval, deeply mottled, and

¹ Gray, A. Bot. Gaz. 5: 63. 1880.

abruptly pointed, petals apparently greenish yellow and smaller (19 mm. \times 9 mm.), anthers pale, and stem apparently purple. Study of further specimens will probably show this to be a distinct thing. In the blotching of the leaves and in the color of the petals it resembles *T. viride*.

Thus, although *T. luteum* has a very limited range, it evidently contains a considerable number of intercrossing races or variations showing unit differences.

8. *T. viridescens* Nutt. Trans. Am. Phil. Soc. II. 5: 155. 1837.

T. sessile var. *Nuttallii* Wats. Proc. Am. Acad. 14: 273. 1879.

T. sessile var. *viridescens* Trelease, Rept. Ark. Geol. Surv., 1888. 4: 225. 1891.

This species agrees with *T. viride* chiefly in its pubescence and narrow petals. It may have originated independently from another member of the sessile group. From *T. viride* it differs most markedly in its larger size, its acuminate leaves, and its mostly purple or red petals.

On hillsides and in rich copses, Kansas and Arkansas.

9. *T. viride* Beck, Am. Jour. Sci. 11: 178. 1826.

This plant is distinct in many features, especially the linear or linear-elliptic, purplish green, clawed petals, and the oblong to ovate, relatively small, 3-5-nerved leaves mottled with whitish spots. The stem is rough-pubescent at the top, and the leaves more or less pubescent on the veining beneath. It is considered to be most nearly related to *T. recurvatum*.

In woods, Missouri to North Carolina, Alabama, and Mississippi.

10. *T. Ludovicianum* Harb. Biltm. Bot. Studies 1: 23. 1901.

According to Harbison, this species is nearest *T. viride* and *T. lanceolatum*. From the former it is separated chiefly by its smooth stem, and from the latter by its shorter stem, broader leaves and sepals, shorter filaments, and straight anthers.

In low, rich woods, Louisiana and Mississippi.

11. *T. lanceolatum* Boykin ex Wats. Proc. Am. Acad. 14: 273. 1879.

T. recurvatum var. (?) *lanceolatum* Wats. Proc. Am. Acad. 14: 273. 1879.

The most striking peculiarities of this species are its slender and usually tall (1-4 dm.) stem, leaves lanceolate or elliptic and strongly blotched, petals linear or linear-oblong, clawed, and filaments as long as the more or less incurved anthers. It is most nearly related to *T. recurvatum*.

Moist woodlands and river bottoms, Georgia to Alabama and Louisiana.

11a. Var. *rectistamineum* Gates, n. var.

Several sheets in the Chapman Herbarium (Mo. Bot. Gard. Herb.) with the number 3869, but without locality, agree with *T. lanceolatum* in foliage except that the leaves are larger (8-10 cm. long) and have much shorter (about 10 cm.), stouter stems. They differ from *T. lanceolatum* conspicuously in the petals, which are broadly lanceolate, tapering at the base but not clawed, 4 cm. long, 18 mm. wide, and dark purple. The sepals are lanceolate, larger than in *T. lanceolatum*, 3 cm. long, 1 cm. wide. The anthers are straight, purple, 2 mm. wide, 9 mm. long, filaments short; the ovary large (8 mm.), styles spreading and recurved. This plant, no doubt, constitutes a distinct species, differing from *T. lanceolatum* especially in the petals, anthers, and ovary, but as the specimens available are without locality and only one shows a complete flower, it seems desirable merely to designate this form as above indicated.

The following specimens probably belong to this variety, although the essential flower characters are not exhibited: Aspalaga, Fla., March, 1897, *Herb. Chapman*, two specimens; Aspalaga Bluff, Gadsden Co., Fla., March 8, 1909, *Roland M. Harper 25*.

12. *T. recurvatum* Beck, Am. Jour. Sci. 11: 178. 1826.

T. unguiculatum Nutt. Trans. Am. Phil. Soc. II. 5: 154. 1837.

This species agrees with *T. lanceolatum* in its tall stems, which are, however, frequently stout, and incurved anthers. It differs in that the filaments are about half the length of the anthers, the leaves ovate-lanceolate, oval or suborbicular, and narrowed into a petiole of variable length. This last feature suggests *T. petiolatum* in which the petioles are, however, usually much longer. This condition has perhaps originated independently in both species through parallel mutations, an interpretation which is greatly strengthened by the fact that similar petioled leaves occur as a variation in *T. grandiflorum* (see page 78).

In woods, Ohio to Minnesota, south to Mississippi and Arkansas.

13. *T. petiolatum* Pursh, Fl. Am. Sept. 1: 244. 1814; Hook. Fl. Bor. Am. 2: 180. *pl.* 192. 1840.

The very short and stout stem with leaves ovate-elliptic to reniform, and petioles as long as, or longer than, the blades, characterize this remarkable species which is in many respects a parallel to *T. grandiflorum* var. *variegatum*. One feels that the former must have originated in connection with a mutation, as the latter obviously has done. *T. petiolatum* differs from *T. recurvatum* not only in the above features but also in its narrowly oblanceolate petals and straight anthers with shorter filaments.

Idaho, eastern Washington, and eastern Oregon.

14. *T. giganteum* (Hook. & Arn.) Heller, Bull. S. Cal. Acad. 2: 67. 1903.

T. sessile var. *giganteum* Hook. & Arn. Bot. Beechey's Voy. 402. 1841.

T. sessile var. *Californicum* Wats. Proc. Am. Acad. 14: 273. 1879; Gard. & For. 3: 320. *fig.* 44. 1890, white form.

T. giganteum is undoubtedly distinct from the eastern *T. sessile*, being constantly much larger in all its parts. The nature and cause of its gigantism is a very interesting ques-

tion. Through the kindness of Dr. T. H. Goodspeed I was able to examine some histological preparations of the young buds of *T. giganteum* and *T. ovatum*. From such examination as I was able to make I could detect no difference between the two species either in chromosome number or in size of cells. It therefore appears probable that the gigantism of *T. giganteum* is a result of increased growth and multiplication of cells rather than increase in the size of the cell unit. I speak guardedly, however, because my comparison was hasty and incomplete.

T. giganteum is characterized by its stout stem, large, round-ovate leaves frequently as broad as long, reaching a length (in specimens observed) of 16 cm. and a width of 12-16 cm. The petals typically are narrowly ovate to lanceolate (extreme size 11 cm. \times 32 mm.), maroon-purple, and the filaments are short, the anthers reaching 2 mm. in length, purple. Mrs. R. M. Austin's No. 19, collected at Butte Creek, near Colby, Butte Co., Cal., July, 1896, agrees with the type except that the petals are white and the leaves constricted at base into a short petiole.

The species extends apparently from Lake and Placer Counties, California, southward to San Luis Obispo County. Particular variations are found most commonly or exclusively in certain localities.

14a. *Var. chloropetalum* (Torr.) Gates, comb. nov.

Plate 7, fig. 1.

T. sessile var. *chloropetalum* Torr. Pac. Rail. Rept. 4: 151. 1856.

T. chloropetalum Howell, Fl. N. W. Am. 1: 661. 1902, in part.

Washington to California, in the coast region.

The variety *chloropetalum* with greenish petals, originally described by Torrey as *T. sessile* var. *chloropetalum* from the "Redwoods," California, is stated by Jepson to be "common on the peninsula of Pt. Reyes in Marin Co." Torrey's diagnosis was "petalis viridulis obovato ellipticis, obtusiusculis, sepala duplo superantibus." The petals in specimens

may be greenish, yellowish, white, or pink, and they also vary in width. In the Napa Valley mostly the white-flowered form occurs. The anthers are yellow.

T. chloropetalum Howell, of Oregon and northern California, differs markedly in having oblanceolate, obtuse, white, erect petals 3–4 lines wide and should therefore probably receive a new and distinct specific name. It is represented by the following specimens:

California: Scott River, Siskiyou Co., April 25, 1910, *Geo. D. Butler 1242* (Mo. Bot. Gard. Herb.); Humbug Creek, April 3, 1910, *Geo. D. Butler 1168* (Mo. Bot. Gard. Herb.), petals 5 cm. long, 15 mm. wide, obtuse; near Hupa, Humboldt Co., 1902, *Mrs. M. H. Manning* (Univ. Cal. Herb., 30093); near Arcata, Humboldt Co., April 2, 1905, *Joseph P. Tracy 2155* (Univ. Cal. Herb., 146219); Buck Mountain, Humboldt Co., June 17, 1913, *J. P. Tracy 4181* (Univ. Cal. Herb., 175295).

In some cases the petals are purple except near the base, as in the following specimens:

California: Loma Prieta, eastern slope, April 4, 1894, *J. B. Davy 468* (Univ. Cal. Herb., 4014); Olema, Marin Co., March 31, 1894, *J. B. Davy 679* (Univ. Cal. Herb., 4015). Occasionally the petals are purple only at the tip.

Crystal Springs Lake, San Mateo Co., March 30, 1902, *C. F. Baker 431*, the collector remarks: "This white or pinkish flowered *Trillium* is the predominant form in moist thickets about the lake, but few purple flowered *Trilliums* being seen here." The petals are also narrow, as in the typical var. *chloropetalum*.

14b. Var. *angustipetalum* (Torr.) Gates, comb. nov.

Plate 8.

T. sessile var. *angustipetalum* Torr. Pac. Rail. Rept. 4: 151. 1856.

The variety *angustipetalum* of Torrey apparently occurs as a variation throughout the range of the species. In other words, the petals vary in width from 2 mm. to 32 mm., and the variation is apparently continuous. Torrey characterized the variety as follows: "foliis basi subito contractes; petalis

lanceolato-linearibus acutis, sepala purpurea fere duplo superantibus. Wet ravines, Washington Mammoth Grove; May 15." It is possible that the narrow-petaled forms predominate in certain localities, e.g., the Sierra Nevadas and about San Luis Obispo County.

The varieties *chloropetalum* and *angustipetalum* therefore represent two independent and continuous series of variations in the petals of *T. giganteum*.

15. *T. pusillum* Michx. Fl. Bor. Am. 1: 215. 1803; Rendle, Jour. Bot. 39: 334. pl. 426, fig. A. 1901.

T. pumilum Pursh, Fl. Am. Sept. 1: 245. 1814.

?*T. Texanum* Buckl. Acad. Phil. Proc. 12: 443. 1861.

This species forms a transition from the sessile-flowered species, of which *T. sessile* may be regarded as the type, to the pedunculate species such as *T. erectum*. Its flower may be quite sessile or on a pedicel 6 mm. in length, as represented by specimens in Herb. Gronovius and Herb. Linnaeus.¹ According to Small,² the pedicel is 1 cm. in length. *T. pusillum* is perhaps most nearly related to *T. erectum*, from which it may have been derived. It differs from that species in its smaller and more slender stature, the thickness of the stem scarcely exceeding 1 mm.; also its leaves are oval to lanceolate, obtuse, the petals delicate, smaller (1.4–2 cm. long), pink instead of purple-brown, and the stamens slightly shorter than in *T. erectum*. The stigmas are united at the base to form a style about 2 mm. long, as in *T. Catesbaei* and *T. affine*. It is probable that Buckley's plant represents a distinct form.

In pine lands, North Carolina and South Carolina.

16. *T. erectum* L. Sp. Pl. 341. 1758; Curt. Bot. Mag. pl. 470. 1800; Lamarek, Encyc. Meth. 8: 102. 1803; Illustr. Gen. Tab. 2: pl. 267, fig. 2. 1823; Lodd. Bot. Cab. 19: pl. 1838. 1832; Fl. Serres 10: 56. pl. 990. 1854–5.

T. rhomboideum Michx. Fl. Bor. Am. 1: 215. 1803; Redouté, Les Liliacées 3: pl. 134. 1807.

¹ Rendle, A. B. Notes on Trillium. Jour. Bot. 39: 334, 335. 1901.

² Fl. Southeastern U. S. 278. 1903.

T. foetidum Salisb. Parad. Lond. pl. 35. 1805.

T. erectum var. *atropurpureum* Pursh, Fl. Am. Sept. 1: 245. 1814; Hook. Fl. Bor. Am. 2: 180. 1840.

T. purpureum Kin, in Ell. Sketch 1: 430. 1817.

T. atropurpureum Curt. ex. Beck, Bot. N. & M. States, 361. 1833.

T. erectum rubrum Clute, Am. Botanist 9: 76. 1905.

Leaves characteristically rhombic, acuminate at the apex, and more or less cuneate at the base; flower fetid, the petals lanceolate or ovate-lanceolate (2.5–4 cm. long), brown-purple, filaments 3–4 mm. in length, nearly as long as the anthers.

In woods, Nova Scotia to Manitoba, south to North Carolina and the mountains of Georgia, Alabama, and Missouri.

16a. Var. *album* (Michx.) Pursh, Fl. Am. Sept. 1: 245. 1814; Curt. Bot. Mag. pl. 1027. 1807; Lodd. Bot. Cab. 19: pl. 1850. 1832.

T. album Small, Fl. Southeastern U. S. 278. 1903, and ed. 2, 1913.

T. rhomboideum var. *album* Michx. Fl. Bor. Am. 1: 215. 1803.

The unit variety *album* occurs sporadically, differing from the species only in pigmentation, the petals being white and the stamens and ovary whitish or pink (e.g. Westville, Conn., May 9, 1885, *W. A. Setchell* [Univ. Cal. Herb., 3974]; Penn., *James Galen* 189 [Univ. Cal. Herb., 3971]). Another series of variations, however, runs to an extreme in a form recognized by Small as a separate species, *T. album*. This differs not only in having white or pinkish petals which are less inclined to be acuminate, but in its smaller flowers and longer anthers (8–11 mm. long) with pale connectives colored like the filaments. There are thus two independent series of variations: one a negative mutation in loss of color without any other change, the other a more gradual transition toward a white flower, accompanied by decrease in size of flower, increase in length of anthers, and other changes, the extreme condition being recognized as *T. album* Small.

Occurs sporadically and occasionally throughout the range of the species.

In addition to the white variety, various intermediate shades of color occur. *T. obovatum* Pursh probably represents one of these, or it may belong with *T. grandiflorum*. It appears probable that these are original variations, and not the result of crosses between the extremes, though the pure white form probably appears directly as a mutation. Specimens from Oswego, Ithaca, and Utica, N. Y., Mt. Carmel, Ill., southern Pennsylvania, Cincinnati, O., and Hennepin Co., Minn., show various intermediate shades, and some from Port Huron, Mich. and other localities are pale purple.

16b. Var. *viridiflorum* Curt. Bot. Mag. pl. 3250. 1833.

T. erectum var. γ . *petalis ochroleucis* Hook. Fl. Bor. Am. 2: 180. 1840.

T. erectum var. *ochroleucum* Hook. ex Macoun, Cat. Canadian Pl. 4: 49. 1888.

T. pendulum Willd. Ges. Naturforsch. Fr. Berlin, Neue Schr. 3: 421. 1801; Hort. Berol. pl. 35. 1816.

Willdenow's figure differs from that in the 'Botanical Magazine' in having the leaves acuminate instead of obtuse. The flowers are also probably smaller.

Rare. Near Annapolis, Nova Scotia, *Macoun* (Cat. Canadian Pl. 1: 48. 1888.). Macoun also mentions a rare form with green petals from Peterboro Co., Ontario.

17. *T. Vaseyi* Harb. Biltm. Bot. Studies 1: 24. 1901.

This plant may be distinguished from *T. erectum* by its "long, slender filaments, smaller stigmas and peduncle, which is deflexed beneath the leaves before anthesis." The flowers are larger and are said by Small often to have a rose-like fragrance, the sepals to be more or less involute above the middle, and the petals ovate or orbicular-ovate, 4-6 cm. in length. Judging from specimens, the plant is also usually larger than *T. erectum*, from which it was probably derived.

Moist woods in high mountains, North Carolina, Tennessee, Georgia, and in Connecticut.

Specimens examined in Mo. Bot. Gard. Herb:

Tomassee Falls, Oconee Co., S. C., 5 May, 1896, *H. D. House* 2094, three specimens; border of Bear Pond, French Mt. (?), 15 May, 1891, *Herb. Chapman*, three sheets. These specimens appear to run into *T. erectum*. Southington, Conn., 30 April, 1897, *C. H. Bissell* 211 (2685). This specimen extends considerably the range of *T. Vaseyi*.

Forma album House, *Muhlenbergia* 6: 73. 1910.

This specimen, from Pigeon Gap, Haywood Co., N. C., has pure white petals, though the anthers and pistil are of the normal purple color.

18. *T. Rugelii* Rendle, Jour. Bot. 39: 331. pl. 426, fig. B. 1901.

This plant agrees with *T. erectum* and *T. Vaseyi* in leaf-shape and resembles the latter in its nodding peduncle. It differs from them in the petals, which are white, round-ovate, the same length and thrice the breadth of the sepals. The filaments are also only one-third the length of the anthers, which are purple. I have seen no specimens of this species.

In the mountains of western North Carolina and northern Georgia.

19. *T. simile* Gleason, Bull. Torr. Bot. Club 33: 391. 1906.

This species differs from *T. Rugelii* in its "much longer stamens, yellow anthers and proportionately longer filaments" ($\frac{1}{2}$ as long as the anthers).

Three localities near the border of North Carolina and Georgia.

20. *T. declinatum* (Gray) Gleason, Bull. Torr. Bot. Club 33: 389. 1906.

T. erectum var. *declinatum* Gray, Manual, ed. 5, 523. 1868.

This species is apparently more nearly related to *T. cernuum* than to *T. erectum*. Unlike the latter species, it has a pleasant, not fetid, odor. From *T. cernuum* it differs in the declined rather than reflexed peduncle, and in the petals,

which are ovate-oblong and always white, while in *T. cernuum* they may be elliptic, oval or ovate, acute, and white or pink. The anthers and capsule of *T. declinatum* are yellow. Like many species of *Trillium*, it varies greatly in size.

Ohio and southern Michigan to Missouri and Minnesota.

The following specimens from Mo. Bot. Gard. Herb. show interesting peculiarities:

Taughannock Falls, Ithaca, N. Y., 14 May, 1892, *H. von Schrenk*. This specimen agrees with *T. declinatum* except that the capsule is purple, the peduncle appears to be erect, and the petals are lanceolate. It may be a white derivative from *T. erectum*. Fountaindale, Winnebago Co., Ill., 1867, *M. S. Bebie* 8229; Armstrong, Emmet Co., Ia., 13 May, 1899, *R. I. Cratty*. These specimens differ from *T. declinatum* in having purple anthers. The former also has narrowed petals. These are perhaps unit variations, and they show that the coloration of petals, anthers, and capsule may vary independently, but in some specimens certain organs are only partly colored.

21. *T. cernuum* L. Sp. Pl. 339. 1753; Curt. Bot. Mag. pl. 954. 1806; Barton, Fl. N. Am. 2: 13. pl. 40. 1822; Meehan's Monthly 10: 49. pl. 4. 1900.

The main peculiarities of this species were mentioned under *T. declinatum*. Its foliage is closely similar to that of other members of the *erectum* group.

In rich woods, Nova Scotia to Minnesota, Georgia, and Missouri.

22. *T. undulatum* Willd. Ges. Naturforsch. Freunde Berlin, Neue Schr. 3: 422. 1801.

T. erythrocarpum Michx. Fl. Bor. Am. 1: 216. 1803; Sweet, Fl. Gard. 3: pl. 212. 1827; Lodd. Bot. Cab. 13: pl. 1232. 1827; Curt. Bot. Mag. pl. 3002. 1830. In this last figure the leaves have short petioles.

T. pictum Pursh, Fl. Am. Sept. 1: 244. 1814.

This species is somewhat isolated from its nearest relatives by a number of peculiarities. The leaves are ovate,

acuminate, rounded at base, with a petiole varying in length from 3 to 20 mm. The petals are oblong or oval to obovate, much longer than the sepals, white, striped with purple, particularly at the base, the margins waved. The anthers are short (about 5 mm.), as long as the filaments, shorter than the stigmas, and apparently reddish. In these features it agrees with *T. cernuum*. The berry is red, whence the name of Michaux.

In swamp woods and bogs, Nova Scotia to Wisconsin, south to Missouri, and in the mountains to South Carolina and Georgia.

23. *T. Scouleri* Rydb. Bull. Torr. Bot. Club 33: 394. 1906.

T. grandiflorum Hook. Fl. Bor. Am. 2: 180. 1840, in part.

T. obovatum Hook. *ibid.*, in part.

This species, *T. grandiflorum*, and *T. ovatum* agree in their main features, especially in flower structure, all having rather broad, white petals. The two western species are widely distinct from *T. grandiflorum*, from which they must therefore have separated long ago. *T. Scouleri* differs from *T. grandiflorum* in the shape of the leaves, which are broadly rhomboid, rounded or truncate at base, and in the petals which are ovate-oblong, subacute.

British Columbia to Montana and California.

24. *T. grandiflorum* (Michx.) Salisb. Parad. Lond. pl. 1. 1805; Lodd. Bot. Cab. 14: pl. 1349. 1828; Regel, Gartenfl. 17: 98. pl. 575. 1868; Garden 36: 394. fig. 1. 1889; *ibid.* 40: 222. pl. 821. 1891; Fl. Serres 10: pl. 991. 1854-5; Meehan's Monthly 4: 17. pl. 2. 1894; Traill, Stud. Pl. Life in Canada, 35. pl. 3. 1906; Rendle, Jour. Bot. 39: 330. 1901.

T. rhomboideum v. *grandiflorum* Michx. Fl. Bor. Am. 1: 216. 1803.

T. erythrocarpum Curt. Bot. Mag. pl. 855. 1805.

This species is markedly characterized by (1) its oval or rhombic-oval, acuminate leaves, more or less cuneate at the sessile or constricted base, (2) its large, oblanceolate or obovate-oblanceolate, erect-spreading petals (reaching 7 ×

3.5 cm.) exceeding the much narrower sepals, crisped, white or sometimes pink, rarely green,¹ (3) the berry red, becoming black. *T. grandiflorum* also differs from the two western species in having the stigma lobes erect, spreading or connivent, much exceeded by the stamens. Another interesting feature is the unilocular ovary, referred to by Salisbury and confirmed by Rendle, who also quotes Mr. Smith of Newry to the effect that there are two very similar forms of *T. grandiflorum*, one of which grows in bogs and the other in dry soil. Compared with *T. erectum*, the ovary of *T. grandiflorum* is much smaller and white, though deeply six-lobed as shown in Salisbury's plate.

Woods and hillsides, Quebec to Minnesota and Missouri, south along the mountains to Florida.

24a. Var. trans. *variegatum* Smith, Bot. Gaz. 4: 181. 1879.
T. grandiflorum Plant World 6: 89. fig. 1. 1903.

This remarkably variable condition of *T. grandiflorum* was described by Smith from Michigan and has been redescribed many times since. It is particularly common in southwestern Ontario, in the Don Valley and elsewhere, and Buffalo and Syracuse, N. Y. (See variation of *Trillium*, p. 72.) In size it appears to be constantly smaller than *T. grandiflorum typica* and to agree with var. *parvum*.

24b. Var. trans. *parvum* Gates, n. var.

Omnino forma typica convenit excepto parvitas omnibus partibus (stipa, folia floraque) et petalibus puniceibus fierens.

I have recently had the opportunity of studying living plants of a variety of *T. grandiflorum* obtained by the Missouri Botanical Garden from Exeter, New Hampshire, where a quantity of the rootstocks were dug up in 1914 by L. E. Williams. They differ from the type of *T. grandiflorum* in nothing except their constantly smaller size and in the fact that they begin to turn pink very soon after opening. Their description is as follows:

¹ A specimen of *T. grandiflorum* with yellow petals has been reported from Galt, Ontario. (Am. Bot. 12: 83. 1907.)

Rootstock horizontal, stem sheathed at base for 2-3 cm., green, usually reddish near the base, smooth, 10-15 cm. high, 4-6 mm. in thickness at base, tapering gradually to 2-3 mm. at the top; leaves rhombic-oval or rhombic-ovate, 4-7 cm. long, 3-6 cm. wide, sessile or nearly so, acute, acuminate; peduncle 2-3 cm. in length, erect, flower bent horizontally; sepals lanceolate, acute or acuminate, 2-3.5 cm. long, 9-14 mm. wide; petals forming a tube at base, spreading above, margin waved, oblanceolate to obovate-oblanceolate, obtuse or broadly acute, sometimes minutely emarginate, 28-44 mm. long, 13-22 mm. wide, white at first, soon changing to pale pink and fading to purplish pink, considerably exceeding the sepals; stamens adnate to base of the petals, filaments white, 5-6 mm. long, anthers 5-10 mm. long; ovary 6-8 mm. long, 6-angled, winged, white, three parietal placentae sometimes nearly meeting in the center, stigmas slender, erect-spreading, 3-4 mm. long.

Specimens examined in Mo. Bot. Gard. Herb.:

Exeter, N. H., March, 1915, *L. E. Williams*, TYPE; Alma, Mich., May 9, 1891, *Chas. A. Davis*; without locality, *E. C. Smith*, two sheets; Edgebrook, Cook Co., Ill., May 11, 1897, *Agnes Chase*, four specimens; Chautauqua, N. Y., May, 1909, *Mrs. C. P. Damon*; Ithaca, N. Y., April 24, 1891, *H. von Schrenk*; Battersea, Ont., May 31, 1893, *J. Fowler*, two specimens; Mountville, (Ohio?), May, 1889, *Mrs. Eby*; Middlebury, Vt., May 3, 1878, *Ezra Brainerd*, three specimens.

25. *T. ovatum* Pursh, Fl. Am. Sept. 1: 245. 1814.

T. californicum Kellogg, Proc. Cal. Acad. 2: 50. fig. 2. 1860.

T. crassifolium Piper, Erythea 7: 104. 1899.

T. obovatum Hook. Fl. Bor. Am. 2: 180. 1840.

This species was described by Pursh as follows: "T. pedunculo erecto, petalis oblongis acutis patentibus calyce lineari paulo longioribus, foliis ovatis sensim acutis arcte sessilibus. On the rapids of Columbia River. *M. Lewis*. 4 April. v. s. Flowers pale purple." The characters of *T. ovatum* must be determined by specimens from the original region. Such specimens have fairly broad sepals and are in-

intermediate in this respect between *T. venosum* and *T. ovatum* var. *stenosepalum*.

T. ovatum may be distinguished from *T. grandiflorum* by its usually narrower and lanceolate petals, which are acute, and color soon changing to rose and dark red. According to Mr. T. Smith of Newry, England,¹ *T. ovatum* opens its flowers earlier, soon after emerging from the ground. Another important difference as regards many specimens is the much shorter stamens (anthers about 6 mm.). This feature is not constant, however, for in some specimens the anthers reach 10 mm. as in *T. grandiflorum*, and there are also intermediate lengths. In his 'Flora of Montana' Rydberg records this species with the statement that the petals are purplish or dark rose-colored, oblanceolate, acute, the sepals narrow and the peduncles very slender.

British Columbia to Montana, Colorado, and California (to Santa Cruz).

Specimens examined:

Washington: Stevens Pass, Cascade Mountains, Aug. 17, 1893, *Sandberg & Leiberg* 770 (Univ. Cal. Herb., 170660), leaves 17×13.5 cm., sepals 19 mm. wide; Tacoma, May 3, 1908, *J. B. Flett* 3430 (Univ. Cal. Herb., 128157); Cascade Tunnel, alt. 3500 feet, July 15, 1911, *M. E. Jones* (Univ. Cal. Herb., 175870), differs from *T. venosum* chiefly in having leaves ovate-rhomboid, not oval, and petals turning purple; *R. H. Platt* 189 (Univ. Cal. Herb., 3985).

California: Dinsmore's ranch, in valley of Van Duzen River opposite Buck Mountain, Humboldt Co., June 26, 1913, *J. P. Tracy* 4350 (Univ. Cal. Herb., 175281); Sherwood Valley, May 29, 1899, *W. C. Blasdale* 1039 (Univ. Cal. Herb., 30092), sepals narrowish, 6 mm., petals drying purple; Comptche, Mendocino Co., June, 1906, *H. A. Walker* 300 (Univ. Cal. Herb., 112751), leaves 17×14.5 cm., sepals 18 mm. wide; near Ukiah, 1897, *Carl Purdy* (Univ. Cal. Herb., 3993); San Leandro Creek, Oakland Hills, San Francisco Bay, March 23, 1901, *H. M. Hall* 875 (Univ. Cal. Herb., 3987); Aptos,

¹ See Rendle, A. B. Notes on Trillium. Jour. Bot. 39: 331. 1901.

April 14, 1903, *C. F. Baker 3010* (Univ. Cal. Herb., 142145), same as Sherwood Valley specimen.

The line between *T. ovatum* and var. *stenosepalum* is not very sharply defined. The differences are discussed under var. *stenosepalum*.

25a. Var. trans. *stenosepalum* Gates, n. var. Plate 6, fig. 2.

Herba glabra, foliis parvis, ovatis, 5-nerviis, breviter acuminate, ad basim rotundo in petiolo perbreve constricto; pedunculo erecto; sepalis brevibus, lanceolatis, acuminate, 13–33 mm. longis, 3.5–6 mm. latis; petalis albis, oblongo-ovatis, obtusis, marginibus undulatis, sepalis multum excedentibus; antheribus 8 mm. longis, flavis stigmatibus multum excedentibus; stigmatibus perbrevibus, tenuis, apicibus recurvatis.

Rootstock horizontal; stem rather slender, 19–30 cm. in length, 3–9 mm. in thickness, purplish above the base, which is sheathed for 3–5 cm.; leaves ovate, 5-nerved, 5.5–10 cm. long, 4.5–7.5 cm. broad, acute, short-acuminate, rounded at the base and sharply constricted into a very short petiole; peduncle about 2–6.5 cm. in length, erect, 1 mm. thick; sepals lanceolate, acuminate, about 13–33 mm. long, 3.5–6 mm. wide, delicate; petals white, oblong-ovate, obtuse, margin somewhat waved, 20–43 mm. long, 10–15 mm. broad; anthers yellow, straight, 8 mm. long, much exceeding the stigmas, filaments 5 mm. long, very slender; stigmas very short (2–3 mm.), slender, nearly erect, tips recurved, ovary yellow, and about 5 mm. in length. The three veins in the sepals are very inconspicuous and in small specimens are only visible with a lens.

This strikingly distinct variety stands between *T. Scouleri* and *T. grandiflorum* in certain respects but shows a number of peculiarities. The leaves resemble those of *T. Scouleri* but are not as small as the minimum size in that species, and scarcely rhomboid. The flowers resemble those of *T. grandiflorum* but are smaller in all their parts. The sepals in particular are greatly reduced in comparison with the petals. The variety *stenosepalum* is separated from *T. venosum* not

only by the entirely different sepals, but by the straight yellow anthers, the very much shorter stigmas, and slightly in the shape of the leaves.

The variety *stenosepalum* is nearly related to *T. ovatum*, and all the specimens cited from Californian localities have hitherto been included under the latter species. It is impossible, however, to include under one name forms which differ so widely, especially in their sepal characters. *T. ovatum* was originally described from Washington, and extends southwards into northern California in Humboldt and Mendocino Counties. Specimens belonging to it also occur apparently in Santa Cruz County. It differs from the variety *stenosepalum* chiefly in that the petals turn pink in drying and the sepals are broader. The two forms overlap in Washington State, but the variety extends further east and south. In certain intermediate areas there appear to be transition forms as regards width of sepals, but specimens of the variety from Montana are entirely distinct from specimens of the species proper from Washington. However, certain specimens having sepals of the species do not turn pink in drying, while the petals of typical forms of the variety do occasionally turn pink in drying. Hence it seems necessary to regard the variety *stenosepalum* as a transitional variety.

Apparently continuous intermediate series occur between all three forms, *T. ovatum*, the variety *stenosepalum*, and *T. venosum*, in intermediate geographic areas. This appears to be a case of continuous geographic variation, yet in their typical form they are so different that all three forms require separate recognition. The sepal differences are the most conspicuous, the sepals varying from 2 cm. wide with 3 prominent nerves in *T. venosum*, to 3 mm. wide without visible nerves in var. *stenosepalum*.

Specimens examined:

Montana: Helena, 1891, *Alderson* (E. Starz, Herb. Whelpley), two specimens (Mo. Bot. Gard. Herb.), TYPE.

Idaho: Paradise Hills, Latah Co., April 18, 1900, *Le Roy Abrams* 548 (Univ. Cal. Herb., 13751); Lake Waha, Nez

Perces Co., June 3-4, 1896, *A. A. & E. G. Heller 3182* (Univ. Cal. Herb., 119597).

Oregon: Yamhill River, Yamhill Co., May, 1879, *Mrs. R. W. Summers* (Univ. Cal. Herb., 72174).

Washington: upper valley of the Nesqually, 1894, *O. D. Allen 58* (Univ. Cal. Herb., 119596).

California: near Marble Mountain, Siskiyou Co., alt. 6000 ft., "10 feet from melting snow," June, 1901, *H. P. Chandler 1550* (Univ. Cal. Herb., 30088). The specimens on this sheet are minimum size, leaves 3×2 cm., stem 10 cm., sepals 10 mm. long. Head of McCloud River, northeastern Shasta Co., June, 1903, *Hall & Babcock 4134* (Univ. Cal. Herb., 54195); Moraga Valley, Contra Costa Co., Feb. 22, 1888, *E. L. Drew* (Univ. Cal. Herb., 13818); Mt. Tamalpais, Marin Co., April 26, 1893, *J. B. Davy 121* (Univ. Cal. Herb., 3989). This is maximum size, leaves 14×11 cm., stem 52 cm. long, sepals 32×9 mm. Same locality, Feb. 22, 1894, *J. B. Davy 798* (Univ. Cal. Herb., 3988); Lagunitas Creek, Marin Co., March, 1896, *Alice Eastwood* (Univ. Cal. Herb., 3994); Sequoia Cañon, Marin Co., Jan. 31, 1892, *Michener & Bioletti 2141a* (Univ. Cal. Herb., 142147); west side of King's Mountain, San Mateo Co., March 18, 1902, *C. F. Baker 329* (Univ. Cal. Herb., 142146); Santa Cruz Mountains, March, 1896, *M. S. Baker* (Univ. Cal. Herb., 72280).

The following range for var. *stenosepalum* can be deduced: western Montana and southern Washington to middle California (Santa Cruz Mountains). The type of *T. ovatum* is somewhat more northerly.

26. *T. nivale* Riddell, Syn. Fl. West. States, 93. 1835; Baker, in Curt. Bot. Mag. pl. 6449. 1879; Selby, in Jour. Hort. Soc. 5: 36. pl. 3. 1890.

This species is so distinct that it is impossible to confuse it with any other. It is probably a derivative from *T. grandiflorum* or from the species from which the latter was derived. The petals are said to be sometimes green,¹ or striped with

¹ Traill, C. P. Studies of Plant Life in Canada, 36. 1906.

red and green, and the petioles of the leaves vary much in length.

In *T. nivale* Riddell the peduncle may be erect, declined or nodding, as in the three species, *T. erectum*, *T. declinatum*, and *T. cernuum* respectively. These conditions in *T. nivale* probably represent unit varieties which would breed true in cultivation, and it is reasonable to suppose that the differences between the above three species have also originated through unit variations. *T. nivale* and *T. rivale* are the most aberrant of the North American *Trillia*. The dwarf character of both may be supposed to have originated through mutations. The leaves of *T. nivale* most nearly resemble in shape those of *T. viride* Beck, though much smaller. In the latter, however, both the leaves and flowers are sessile, while in *T. nivale* the leaves are short-petioled and the flowers rather short-peduncled, so that a close relationship cannot be assumed.

T. nivale differs chiefly from its probable ancestor, *T. grandiflorum*, (1) in being a dwarf, (2) in the shape of the leaves, which are oval, obtuse, with short petioles, instead of rhombic-oval, acuminate, sessile, and (3) in the shape of the petals, which are oblong or oval instead of oblanceolate or obovate-oblanceolate and mucronate. If we compare these differences with those between *Oenothera Lamarckiana* and its dwarf mutant *Æ. nanella*, we see that the differences (1) and (2) above might have originated at one stroke, though as regards (2) the condition is reversed, for in *Æ. nanella* the leaves are mostly sessile, while in *Æ. Lamarckiana* they are petioled. The difference (3) in the petals of *T. nivale* would probably have required another and independent step. At any rate, although the species is so aberrant in the genus, two mutations are sufficient to account for its origin. According to the older views, one must have assumed a long period of isolation and gradual selection to produce such a form. Now we know that there is no necessary relation between the length of a step and the time taken to produce it. A relatively wide mutation will happen just as quickly as a narrow one, and, indeed, if the wider difference has any survival value it

will lead to the supplanting of the original type more quickly than when the step is a narrow one.

Western Pennsylvania to Ohio and southeastern Minnesota, south to Kentucky and Nebraska.

27. *T. rivale* Wats. Proc. Am. Acad. 20: 378. 1885.

This species has perhaps been derived from *T. ovatum* through a dwarf mutation and other changes, in the same way that *T. nivale* has probably been derived from *T. grandiflorum*. Like *T. nivale* it is a dwarf, but here the resemblance ceases except that the leaves are petioled. It resembles *T. ovatum* in its recurved stigmas, but differs in every other part. The leaves of *T. rivale* are not only very much smaller but they are ovate (not rhombic-ovate), rounded or subcordate at base (not cuneate), and petioled (not sessile). The flowers are much smaller, the sepals more broadly lanceolate, the petals subrhombic, narrowed to a claw, white but speckled with purple near the center.¹ In *T. ovatum* the petals are white, soon changing to rose color and dark red. The distinctions of *T. rivale* are so numerous that it is not profitable to conjecture further concerning its origin. The extremes of size variation observed are as follows: stems 8–24 cm. long, 1–3 mm. thick, peduncle 6–8 cm. long, leaf-blade 3–7 cm. long, 1.7–4 cm. wide, petiole 6–23 mm. long, sepals 9–15 mm. long, 5–8 mm. wide, petals 15–27 mm. long.

In the coast mountains of northern California and southern Oregon.

28. *T. Catesbaei* Ell. Sketch 1: 429. 1821.

Solanum triphyllon; flore hexapetalo, carneo Catesb. Nat. Hist. Car. 1: 45. pl. 45. 1771.

T. cernuum L. Sp. Pl. 339. 1753, in part.

T. nervosum Ell. Sketch 1: 429. 1821; Lodd. Bot. Cab. 19: pl. 1860. 1832.

T. stylosum Nutt. Gen. 1: 239. 1818.

This species and *T. affine* are markedly different from the other pedunculate species of *Trillium*. In them the stigmas

¹ According to Howell (Fl. N. W. Am. 1: 661. 1902), this is apparently present in some specimens and absent in others.

are united at the base into a short style, a peculiarity which has appeared apparently independently in *T. pusillum*. The nearest relative of *T. Catesbaei* is probably *T. cernuum*, from which the main distinctions are as follows: In *T. cernuum* the leaves are rhombic, 3-nerved, acuminate, and more or less cuneate at the base; in *T. Catesbaei* they are elliptic or oval, 5-nerved, acute or acuminate, and constricted at the base into a short petiole. The peduncle is nodding in *T. cernuum*, and strongly recurved or sometimes declined in *T. Catesbaei*. The petals in *T. cernuum* are elliptic, oval or ovate, about 2 cm. long, acute or obtuse, revolute, white or pink; in *T. Catesbaei* they are oblong or oblong-lanceolate, reaching more than 4 cm. in length, obtuse or abruptly pointed, crisped, recurved, pink or rose-color. In *T. Catesbaei* the stamens are much longer, reaching 18 mm. (8 mm. in *T. cernuum*), and the filaments are longer than the bright yellow recurved anthers. Yet another difference exists in the absence of a style in *T. cernuum* and its relatives.

In woods, North Carolina and Tennessee to Georgia and Alabama.

29. *T. affine* Rendle, Jour. Bot. 39: 334. 1901.

This species is known only from specimens collected by Rugel in Georgia. It evidently belongs with *T. Catesbaei* from which it is differentiated, according to Rendle, by its "broader sepals, smaller not undulate petals, shorter stamens, and leaves broader above the middle." The filaments in particular are only about 4 mm. long. *T. affine* recalls *T. cernuum* in size and habit of leaf and flower, but like *T. Catesbaei*, differs in its longer stamens exceeding the stigmas, and in the union of the latter at the base.

30. *T. venosum* Gates, n. sp.

Plate 6, fig. 1.

Herba caule robusto, foliis ovato-rhomboideis, 5-7-nerviis, breviter acuminatis; pedunculo erecto; sepalis oblongo-lanceolatis, 3.5-5.8 cm. longis, 14-20 mm. latis, 3-5-nervatis; petalis albis, ovato-oblongis, marginis crispis; antheris rubicundis, apicibus foras curvatis, stigmata superante; stigmati-

bus divergentibus apicibus recurvatibus ovario flavo excedentibus.

Stem stout, 5–10 mm. in diameter, 2–3.5 dm. high, purplish, sheathed at base for a distance of 6 cm.; leaves rhomboid-ovate, 5–7-nerved, 6–11 cm. long, 5–8 cm. wide, acute, short-acuminate; peduncle 3 cm. long, erect, purplish, 2 mm. thick; sepals large, and with 3–5 prominent veins, oblong-lanceolate, broad-pointed, 3.5–5.8 cm. in length, 14–20 mm. in width; petals white, ovate-oblong, obtuse-pointed, with crisped margins, 3.5–5.5 cm. long and 1.4–1.5 cm. wide; anthers 8–15 mm. long, bright pink, curved outwards at the summits, slightly surpassing the stigmas, filaments about 5 mm. long, dilated at base; stigmas slender, 10 mm. in length, somewhat divergent, recurved at the tip; ovary yellow, about 10 mm. long.

This species is nearest *T. Scouleri*, of which I have not seen specimens. In Rydberg's description of that species the sepals are not mentioned, but the large conspicuously veined sepals of *T. venosum* could scarcely have been overlooked had they been present on Rydberg's species. The present species is intermediate between *T. grandiflorum* and *T. ovatum* in size and shape of petals and length of anthers. In specimens of *T. grandiflorum* from the more western part of its range, e.g., Milwaukee, Wis., the sepals are 5-nerved but they are much narrower and the veins are less prominent than in *T. venosum*.

The main distinctions of *T. venosum* from *T. Scouleri* are in the broad sepals with their prominent veins, the pink color of the anthers, and the 5 rather prominent veins of the leaves. The petals appear to resemble closely those of *T. grandiflorum* in several features.

Specimens examined:

Dry Buck, Boise Co., Idaho, 10 May, 1911, *J. Francis Macbride* 847 (Mo. Bot. Gard. Herb. and Univ. Cal. Herb., 163236), TYPE. I reproduce here the cotype specimen because it is larger than the type specimen and shows the characters better.

The following specimens come nearest to *T. venosum* but differ in certain features:

Cuprum-Peacock Mine road, Seven Devils Mountains, Idaho, alt. 7000 ft., July 11, 1899, *W. C. Cusick* 2232 (Univ. Cal. Herb., 3986). In this species the petals turn purplish, as in *T. ovatum*, and the leaves have short petioles (6 mm.). Five miles from Crescent City, Del Norte Co., Cal., April 2, 1902, *P. E. Goddard* 309 (Univ. Cal. Herb., 30086), petals 7 × 3 cm. (resembling *T. grandiflorum*), sepals 5 cm. long by 12 mm. wide, leaves 10 cm. long by 8.5 cm. wide.

The following, with very large, broad, subacute petals, broad, unnerved sepals, and very broad rhomboid leaves, fits neither *T. venosum* nor *T. ovatum*, and should be considered as distinct: Eureka, Humboldt Co., Cal., April 13, 1913, *J. P. Tracy* 4034 (Univ. Cal. Herb., 176190), petals 60 × 35 mm., sepals 40 × 19 mm., obtuse, leaves 15 cm. wide by 14 cm. long, stem stout. This specimen appears to resemble *T. Scouleri*.

31. *T. obovatum* Pursh, Fl. Am. Sept. 1: 245. 1814.

T. grandiflorum var. *obovatum* Farwell, Eleventh Ann. Rept. Comm. Parks and Boul. Detroit, 53. 1900.

This plant, according to Farwell, differs from *T. grandiflorum* in having much smaller petals which are rose or pink. His plants may really belong to var. *parvum*. Reichenbach's plate and description,¹ under the name *T. obovatum* Pursh, of plants collected in Kamtschatka and communicated by Ledebour, represent a distinct plant, differing from *T. grandiflorum* especially in having shorter peduncle, petals white, pale rose color, or lavender, very short filaments and style, stigma subcapitate, the very short lobes reflexed. It is undoubtedly distinct from *T. obovatum* Pursh and *T. Kamtschatikum* Pall.,² differing from the latter in certain minor features. Pursh's original plants were from Montreal, and a study of the species should be made in that vicinity. Its exact characters cannot be understood until this is done. Rydberg, in his 'Flora of Montana,'³ records *T. obovatum*

¹ Ic. Bot. Exot. 1: 21. pl. 29. 1827.

² Ledebour, C. F. Fl. Ross. 4: 121. 1853. See also Rendle, Jour. Bot. 39: 329. 1910.

³ Mem. N. Y. Bot. Gard. 1: 102, 472. 1900.

Pursh with the statement that it is distinguished from *T. ovatum* Pursh by its obovate, white, or rose-colored petals.

The relationships of the species of *Trillium* seem complex and confusing because of the numerous cross-relationships which appear. But the difficulties of interpretation are, I believe, considerably clarified when we realize (1) that particular elements of the germ-plasm vary independently of each other and that (2) the variation of a single germinal element may affect the external morphology in various parts of the organism. The application of these two principles helps to clear up what may otherwise become a hazy maze of relationships. This is particularly true of large genera, in which the number and diversity of species greatly exceed that of *Trillium*.

The genus is naturally divided into two groups having respectively pedunculate or sessile flowers. Whether the sessile-flowered gave rise to the pedunculate group or *vice versa* is difficult to say, but it appears probable that the transition from one condition to the other occurred but once (presumably through a mutation) since there appear to be no cross-relationships from one group to the other. I mean by this that the members of each group may be considered to be descended from one ancestor, and e.g., none of the characters of the pedunculate group are such as might have been derived from particular members of the other group. On the contrary, within each group parallel mutations have probably taken place, as in the dwarf origin of *T. rivale* and *T. nivale*.

VARIATION OF TRILLIUM

The genus *Trillium* has long been known to botanists and horticulturists for its variability. Nearly all parts of the plant vary, particularly the shape of leaves and petals, and the color of the petals. On the other hand, the size of the plant and the relative length of filaments and anthers is usually constant within certain limits, and the latter is frequently used as a specific differential, though it too is subject to some variation. The number of members in the whorls

of leaves or flower parts also varies, as well as (rarely) the number of whorls. Teratological variations are relatively abundant and have been described in many of the species, particularly *T. grandiflorum* Salish., *T. erectum* L., and *T. sessile* L. A number of these records have been brought together below, and a more exhaustive search in semi-popular journals would doubtless add to the list.¹

Cowles, S. N. Am. Nat. 3: 102. 1869.

At Otisco, N. Y., two specimens of *T. erythrocarpum* Michx. with pistillate flowers and 9 petals were collected. The extra petals replaced the stamens and were somewhat smaller than normal.

Matthews, G. F. Am. Nat. 3: 382. 1869.

At St. John, N. B., one specimen of *T. erythrocarpum* Michx. was gathered with 4 leaves, 4 sepals, 4 petals, and 8 stamens.

Fisher, R. A. Am. Nat. 4: 46. 1870.

At Arba, Ind., one specimen of *T. sessile* L. was found with parts in fours, and one specimen of *T. recurvatum* Beck with 2 leaves, 2 sepals, 2 petals, 4 stamens, 2 stigmas.

Hankenson, E. L. Bull. Torr. Bot. Club 1: 21. 1870.

T. grandiflorum at Newark, Wayne Co., N. Y. "Forms found here have petals more or less turned to green, with long petioled smaller leaves, borne lower down on the stem; or with stem leaves *entirely wanting*, and a single radical leaf instead. The calyx of the leafless stemmed form appears larger and more leafy."

Hall, I. H. Bull. Torr. Bot. Club 1: 21. 1870.

T. erectum L. var. *album* Pursh, in central and western New York. The author thinks the variety *album* and normal red may appear from the same rootstock in successive years. The variety *album* is normally a starveling, smaller. The color of the petals varies from creamy yellow or greenish white to the normal purple, sometimes with a blush of purple

¹ Certain of these facts were referred to elsewhere. See Gates, R. R. Teratology and phylogeny in the genus *Trillium*. Science N. S. 42: 879. 1915.

in central part of the petal, sometimes with faint, streaky tinges of purple lengthwise of the petal, though not at all like *T. erythrocarpum* Michx. It has also less scent. Hall thought it was simply an unhealthy state of *T. erectum*.

T. erectum frequently occurs with the peduncle bent down under the leaves as in *T. cernuum* L. The peduncle is sharply bent at an angle just above the leaves, and not merely curved or drooping.

Hall, I. H. Bull. Torr. Bot. Club 1: 36. 1870.

A plant of *T. erectum* var. *album* Pursh dug up has kept its "creamy green" color every year for 5 or 6 years.

Osborne, C. S. Am. Nat. 4: 125. 1870.

At LeRoy, N. Y., *Trillium* sp. was seen with 2 stems from the same rootstock; one had petals and sepals alike except for the white margin to apex of petals, and the other had petals oblong, pure white with narrow green stripe down the center.

Coleman, N. Bot. Gaz. 2: 90. 1877.

The author found one specimen of *T. grandiflorum* having 4 leaves, 4 petals, 4 sepals, 4 stamens, 2 stigmas, and a 4-angled ovary, and a specimen of *T. erythrocarpum* var. *Clevelandicum* Wood having 6 sepals and 15 petals, all green.

Gray, A. Am. Jour. Sci. 15: 153. 1878.

T. erythrocarpum Michx. with polymerous flowers, found by Pastor J. H. Wibbe near Oswego, N. Y., has been a constant feature since discovered "five years ago." The specimen in Gray Herb. is described by Deane (*vide infra*). It has 8 sepals (one with a white petaloid growth attached), 8 petals, at least 20 stamens, and a whorl of 7 leaves, one of which is forked at the tip.

Gray, A. Two remarkable forms of *Trillium*. Bull. Torr. Bot. Club 6: 272. 1878.

Two specimens from St. Louis, Mich. are described: one of *T. grandiflorum* with petioles to the leaves and a green

stripe down the center of the petals; the other having similar petals and enlarged foliaceous sepals but no whorl of leaves. Further records of this var. *variegatum* in Bull. Torr. Bot. Club 6: 277-278. 1878.

Smith, Erwin T. A Michigan Trillium. Bot. Gaz. 4: 180-181. 1879.

T. grandiflorum var. *variegatum* is described. It differs chiefly from the species in having a greenish stripe down the center of the petals, which are typically obovate-mucronate, leaves long-petioled, broadly ovate, acuminate, and ovary green. It was found to occur commonly every year and to be well distributed. It is very variable in shape of petals, length of petioles, etc., and the stem also may be leafless or the calyx enlarged to form leaves.

This remarkable condition of *T. grandiflorum* has since been found and studied in a number of localities, though it has not usually been known under the name var. *variegatum*.

Wright, S. H. Bot. Gaz. 4: 232. 1879.

The author found the above form at Penn Yan, N. Y., and received specimens of it from Lockport, N. Y.

James, J. F. Bull. Torr. Bot. Club 10: 57. 1883.

At Cincinnati, Ohio, was found a specimen of *T. sessile* which was pentamerous—5 leaves in a whorl, 5 sepals, 5 petals, 8 stamens, 4 stigmas, 4-celled ovary, one of the petals having an anther on one side.

Tracy, Mrs. C. T. Bull. Torr. Bot. Club 10: 71. 1883.

At Ripon, Wis., a plant of *T. cernuum* L. was discovered with one of the sepals replaced by a leaf, and two of the petals with a green stripe through the center.

James, J. F. Bot. Gaz. 9: 113. 1884.

A plant of *T. erectum* L. was found, which was tetramerous, having an extra leaf on the stem above the whorl of three, 4 sepals, 4 petals, 8 stamens, 4 stigmas, and a 4-celled ovary.

Two of the sepals were half green, the other half colored like the petals.

Dudley, W. R. Bull. Cornell Univ. 2: 99. 1886.

Dudley records a plant of *T. erectum* L. with green flowers, and one of *T. grandiflorum* Salisb. showing synanthly and virulence, the double form being cultivated.

Fermond, Ch. Essai de phytomorphie 2: 298. Paris. 1886.

The author speaks of isolation and displacement of single leaves.

Foerste, A. F. Bot. Gaz. 16: 163. 1891.

A specimen of *T. sessile* L. is described having a whorl of 4 leaves, and flower parts in threes but partly arranged as though in fours, i.e., a sepal takes the place of a petal, and one segment is half sepal, half petal.

Foerste, A. F. Bot. Gaz. 19: 460-465. 1894.

The following conditions in *T. sessile* L. from Dayton, Ohio, are carefully described, showing the phyllotactic arrangement of parts: (1) leaves and flower parts all in fours, tetramerous; (2) partly with leaves decussate in pairs, stamens and stigmas in threes, other abnormalities; (3) a similar condition with an apparent "attempt to maintain a quaternary phyllotaxy, after numerically they have gone over to the normal ternate form"; (4) whorls of parts 3, 4, 3, 4, 3, 4, but quaternate position maintained even when the number of parts is 3.

The detailed description of one of the specimens is as follows: "A pair of opposite broader leaves, followed in decussating order by a pair of narrower leaves," an outer and an inner pair of sepals, then 4 petals decussating with the two sets of sepals taken as a whole, 4 outer stamens, 4 inner stamens, and an ovary with 4 styles.

Osband, Lucy A. Am. Nat. 28: 706. 1894.

At Ypsilanti, Mich., was found a plant of *T. grandiflorum* Salisb., double, having 2 sets of sepals and 2 of petals, the

outer petals striped, except one which was half white, the inner petals white except a thread of green through the center of one; stamens and ovary also abnormal.

Owen, Maria L. Bot. Gaz. 19: 337-338. 1894.

Specimens of *T. cernuum* L. from Canobie Lake, N. H., with the following peculiarities, were found:

1. About an inch above the normal leaf whorl were 3 whorls of 3 leaves, each close together, forming a rosette; flower erect, rather large, petals 11×4 lines, with a white stripe down the center and a green one on each edge; stigmas 4; one petal 2-parted.

2. Above the normal whorl 2 whorls close together, and a third extra whorl $\frac{1}{2}$ inch above this, at the base of the flower; petals green and white; one stamen abortive; stigmas 2. Several similar specimens collected from the same locality.

Eastwood, Alice. Erythea 4: 71. 1896.

The following three abnormal specimens of the white-flowered form of *T. giganteum* were found in the San Bruno Hills of San Mateo Co., Cal.: (1) with four leaves, "all parts of the flower in fours even to the ovary," stamens 8; (2) with six leaves (not stated whether these were in 1 whorl or 2), 6 outer divisions of the perianth and 5 inner, 10 stamens, and 6 cells to the ovary; (3) one of the outer perianth segments a "true leaf," symmetry otherwise normal.

Smith, Arma A. Abortive flower buds of Trillium. Bot. Gaz. 22: 402-403. 1896.

Davis, C. A. Trillium grandiflorum (Michx.) Salisb.; its variations normal and teratological. Proc. Am. Assoc. Adv. Sci. 46: 271-272. 1898.

Nearly all the variations found in this species are described.

Kellerman, Mrs. W. A. Asa Gray Bull. 6: 18-20. fig. 4-5. 1898.

Mrs. Walker found a double specimen of *T. grandiflorum* Salisb. growing in woods in Jefferson County, Ohio. She re-

moved it to her garden where it bloomed for 10 years, always producing the double flower. The root afterwards was divided, and one portion produced 3 stems, all with double flowers. Two of these were dissected, one having 9 whorls, the other 13 whorls of petals in cycles symmetrically alternating. The stamens and pistils were almost completely aborted and there were no seeds. Except for this doubling, the plants were normal.

Macoun, James M. Canadian Rec. Sci. 7: 476. 1898.

Monstrosities of *T. grandiflorum* Salisb. are not uncommon in southwestern Ontario. These evidently refer for the most part to var. *variegatum* Smith. A fine series was examined from Mr. J. Dearness, London, Ont., Mr. R. Cameron, Niagara, Ont., Mr. J. M. Dickson, Hamilton, Ont., and Mr. Wm. Scott, Toronto, Ont. Mr. Dickson found that they occurred in different years in the same locality and noted the following types:

1. Several with white edgings and markings on the sepals. The most remarkable had 1 sepal green, 1 half green, half white, and 1 pure white; sepals and petals spirally inserted; leaves normal.
2. Leaves and sepals normal; petals marked with green lines or bands towards the base.
3. Leaves and sepals normal; petals green with a narrow white margin.
4. Leaves distinctly petiolate; petioles 1-3 inches long; sepals white with a green stripe down the middle; petals narrowed, lanceolate, white with a broad green band in the center from base to apex.
5. Leaves as in the former type; sepals normal; petals obovate, apiculate, long-clawed, with broad green centers and white margins.
6. Leaves ovate, long, acuminate, petioled; petioles ascending, widely spreading, 7 inches long, inserted about 2 inches above the rootstock and 6 or 7 inches below the flower; sepals normal; petals green with white margins. All the flowers appeared to be perfect, though there was an occasional

sterile filament. One plant, evidently representing the type of var. *variegatum*, was photographed, and a drawing from the photograph was published in the 'Plant World,' vol. 6, page 88.

Among the plants sent to Mr. Macoun by Mr. Cameron from Niagara was one with its petals changed into petioled leaves (petioles over 1 inch long). Mr. Cameron also collected and photographed a plant found on Navy Island, Niagara River, in 1896, very large-flowered, having 21 pure white petals. The root was transplanted, and in 1897 produced 2 flowers, each having 21 petals. This is very good evidence showing how closely these things come true in vegetative reproduction. The same collector also reported a double yellow-flowered dwarf specimen from Niagara Falls, which probably belonged to another species.

Several sheets of specimens in Mo. Bot. Gard. Herb., collected by Mr. William Scott in the Don Valley near Toronto, in 1896, belong to *T. grandiflorum* var. *variegatum* and show a great range of variation.

Holzinger, John M. A green Trillium. *Plant World* 4: 132. pl. 9. 1901.

T. grandiflorum, collected at Winona, Minn., had its flower parts all green, 6 whorls of 3 leaves each, no stamens or carpels.

Pollard, Chas. L. Double Trilliums. *Plant World* 4: 213. fig. 1. 1901. (Reprinted from *Asa Gray Bull.* 6: 18-20. 1898.)

No new record, merely a comment on Mrs. Kellerman's record. This differed from the above in having the parts colored, hence "double" in the ordinary sense.

Rendle, A. B. *Jour. Bot.* 39: 331. 1901.

The author mentions a specimen of *T. grandiflorum* from Goat Island, Niagara (not Nicaragua), whose leaves have petioles 1 cm. long, and another specimen a "monstrous form" from Syracuse, N. Y. (from Gray Herb.), with leaf stalks as much as 3 cm. long.

Bishop, Irving T. *Plant World* 5: 11. 1902.

A variety of *T. grandiflorum* was noticed to be common near Buffalo, N. Y., students obtaining many specimens every spring. (This is evidently the var. *variegatum*). The petals become more or less green and bract-like, the leaf-blade smaller, and the petiole and peduncle become longer. In some cases the peduncle is longer than the rest of stem; in others, the petiole is 4-6 inches long, with a narrow lanceolate blade 3 inches long. Multiplication of organs is common, extending to petaloid and bract-like forms and also to the leaves. In *T. erectum* L., in few cases, the whorls are repeated, but in no case is there lengthening of leaf- and flower-stem.

Britcher, H. W. Variation in *Trillium grandiflorum* Salisb. *Me. Agr. Exp. Sta. Bull.* 86: 169-196. *pl.* 9-13. 1902.

This is a careful study of the variation in the plants found in quantity near Syracuse, N. Y. Hundreds of thousands of plants grow there, thousands of them abnormal, perhaps 10 per cent. In some spots barely a half-dozen are abnormal among thousands of plants; near-by 10-15 per cent may be abnormal. In typical plants the petals vary from narrow and pointed to broad and obtuse, but always mucronate.

An elaborate series of measurements is given for 185 plants, with notes on their peculiarities. In addition to the other conditions described, Britcher found that the petals, sepals, or ovary might be stalked.

Only the range of these remarkable variations can be recorded here. The petals varied in color "from typical white or pink, through white with green center stripe to solid green." Green petals or portions of petals are usually persistent, gradually becoming purplish brown in color. The abnormal plants have usually entirely disappeared by the time the carpels of the normal plants have attained their full size. This is interesting as showing that the abnormal forms do not reproduce themselves by seed and must therefore arise by repeated mutations from the normal forms.

The stem may be wholly absent or as much as 34 cm. in length. The leaves vary from sessile to petiolate with petioles

16 cm. long. The peduncle varies from 2 to 220 mm. in length. The sepals may be sessile or on stems 44 mm. long, and similarly the stalks of the petals may reach 64 mm., the ovary stalks 23 mm. The stem-leaves are sometimes absent.

From the fact that the same rootstock produces the same peculiar condition year after year, as has been shown by transplanting the specimens, it is evident that the various abnormal conditions are inherited and not environmentally produced, as has been so frequently conjectured; though the type of abnormality produced by a given rootstock will perhaps vary within limits from year to year. It would be interesting to know what these limits of variation are for individual rootstocks showing different stages of the abnormality.

Hopkins, Lewis S. A rare freak of the Trillium. *Plant World* 5: 182-183. *fig. 1.* 1902.

In Troy, Ohio, was found *T. sessile* L. with three stems arising together from rootstock. The first stem had 3 whorls of 3 leaves each, the lower 2 crowded together, 4 petals, no sepals, 5 stamens, 3 styles and stigmas, and ovary 6-angled. The second stem had 2 whorls of 3 leaves each, no sepals, 6 petals, 7 stamens, 4 styles and stigmas, and 8-angled ovary. The third stem had leaves as in the second, but 3 sepals, 6 petals, 9 stamens, 2 styles and stigmas.

Morris, E. L. "Occasional" leaves of Trillium. *Plant World* 5: 92-93. *pl. 13.* 1902.

Near Washington, D. C., was found a plant of *T. sessile* L. bearing two single leaves with very long petioles, direct from the rootstock.

Morris, E. L. Abnormal Trilliums. *Plant World* 6: 87-89. *fig. 1.* 1903.

This figure is a plant of *T. grandiflorum* var. *variegatum* from Hamilton, Ont. Two specimens from Moose Head Lake, Maine, 1898 (Aug.), collected by G. B. Grant, "have the simple leaves long-petioled from the rootstock." Probably these free, single, long-petioled leaves are an extreme case

of the *variegatum* condition with long-petioled leaves from near the base of the scape.

Beattie, F. S. *Rhodora* 7: 40. 1905.

A specimen of *T. undulatum* Willd. from Gloucester, Mass., had two stems from one rootstock. One of the flowers had one of its sepals enlarged to $\frac{2}{3}$ the length of ordinary leaves and the shape nearly that of a leaf. At Rowe Pond, Somerset Co., Me., twin stems in this species were found to be the rule.

Gary, Lester B. Variation in *Trillium*. *Plant World* 8: 257-259. 1905.

A plant of *T. erectum* with cream-colored petals and diminished odor, but ovary red, was found in the gorge near Niagara whirlpool where *Trillium* is abundant.

The various common variations of *T. grandiflorum*, green petals, long petioles, etc., are described.

Andrews, F. M. Some monstrosities in *Trillium*. *Plant World* 9: 101-102. fig. 17. 1906.

The following are described:

One specimen of *T. sessile*, with all stamens and carpels transformed into floral leaves, 14 in number.

All stamens and carpels of a plant of *T. recurvatum* transformed into floral leaves, larger than normal, 23 in number.

One specimen of *T. sessile*, with 4 leaves, 3 small sepals, 4 large, partly greenish petals, 6 small stamens and styles.

Other specimens of these two species had a sepal and petal "grown together," partly or wholly, one half green, the other half colored (cf. Foerste). Similar observations were made with other species.

One specimen of *T. erectum* with 3 leaves, 3 sepals, 5 petals, 4 stamens, 2 styles.

Slight deviations, in tendency to union of floral parts in *T. nivale*.

Clute, W. N. A remarkable change of color in *Trillium*. *Am. Bot.* 14: 33-35. 1908.

In 1907 a number of plants of the red *T. erectum* were sent to Joliet, Ill., from New Britain, Conn., some of them being still in flower. They were set out and flowered in 1908, but all the flowers but one were white, this one having only a trace of red on the stamens.

Deane, Walter. *Rhodora* 10: 21-24. 1908.

At Squam Lake, Holderness, N. H., Mr. DeMeritte in 1907 found two stems of *T. undulatum* Willd. growing together and having the same peculiarities. They possessed 3 whorls of 3 leaves each, separated by internodes. The leaves on one of the specimens, which was collected, are carefully described and measured.

Two specimens of the same species from Brunswick, Me., in Gray Herb., collected by Mr. Swallow, but without date, show in other cases sepals leaf-like, ovate, and taper-pointed, 8.2-9.2 cm. long. Another specimen in Gray Herb., collected by Miss K. L. Kimball at Fitzwilliam, N. H., in 1891, has its leaves, sepals, petals, and styles in fours, the stamens probably 8.

Deane, W. *Rhodora* 10: 214-216. 1908.

In 1908, Mr. DeMeritte found in the same spot as the previous year a cluster of five plants; (a) three of which had 3 whorls of 3 leaves each; (b) one had 2 whorls of 3 leaves each; and (c) one had 4 whorls of 3 leaves each; in addition, another plant (d) at a little distance had a whorl of 4 leaves.

(b) This plant had sepals 9 cm. long resembling leaves, 4 petals (two formed by chorisis), 3 stamens (opposite the petals), 3 styles, ovary 2-celled.

(c) In this plant the petioles of the lowest whorl of leaves were 7 cm. long, and there were 3 large sepals 5 cm. long, 3 stamens (opposite the sepals), 3 styles, ovary 1-celled.

(d) One of the 4 leaves had a broadly winged petiole; there were 4 sepals, 3 petals, 6 stamens, 4 styles, ovary 4-celled.

In 1897, at Farmington, Me., Mr. C. H. Knowlton collected a specimen of *T. undulatum* having a whorl of 4 leaves with

all the other parts in threes, one stamen more or less petaloid, and the ovary 1-celled with three parietal placentae.

A specimen of *T. undulatum* in Mo. Bot. Gard. Herb., collected by Dr. J. M. Greenman at Mt. Mansfield, Vt. (Plants of Vermont, No. 1253), 2-4 July, 1897, has a whorl of 4 leaves. There are apparently 4 sepals and 4 petals in the flower, but the number of stigma lobes is 3.

Deane, W. *Rhodora* 12: 163-166. 1910.

In this record Mr. De Meritte examined in 1909 the same spot visited in the two previous years. He found (a) 3 plants having 3 whorls of 3 leaves each, separated by internodes, and a perfect flower; (b) 1 plant having 2 whorls of 3 leaves each and a double flower. One of the plants in (a) was collected and carefully described by Mr. Deane. Two of the leaves in the uppermost whorl had a lobe on one side, while the third was notched; the ovary was 1-celled with 3 parietal placentae. The plant (b) possessed 3 sepals, 6 petals; of the latter, two in the outer row had a broad green band running down the center, the third a narrow light green line down the center, and the rest were normal in color; ovary 2-celled.

A specimen of *T. erectum*, collected at Glen Road, N. H., is described. The parts were as follows: a whorl of 4 leaves; 5 sepals green with an edging of maroon, 2 also streaked with maroon; 4 petals and a vacant space for the fifth; 8 stamens, 1 with the anther partly doubled; ovary 8-winged, 1-celled.

Deane, W. *Rhodora* 13: 189-191. 1911.

A specimen of *T. ovatum* Pursh, collected by Mr. W. T. Putnam at Lake Cushman, Wash., had 24 petals in regular alternating cycles of 3 each, pink and white instead of purple, no stamens or pistil. Deane also cites Prof. Wm. R. Dudley,¹ who obtained from Woodwardia Swamp Woods a double *T. grandiflorum* having about 14 parts to the perianth.

In a collection of rootstocks of *T. grandiflorum* var. *parvum*, from Exeter, N. H., which were dug up in 1914 and which were potted and bloomed at the Missouri Botanical

¹ Cayuga Flora, 99. 1886.

Garden in March, 1915, one rootstock is of teratological interest. It produced three stems exactly alike. In every case the flower and peduncle were entirely absent, and there was a whorl of 6 rather small (about 5 cm. long), nearly equal leaves. This rootstock has been marked and will be observed to determine whether the same abnormality occurs every year.

It is evident that most of these scattered records were unknown to those who recorded their own observations. It is therefore useful to bring a number of them together, and no doubt this list can be considerably added to. *T. grandiflorum* appears to be the most variable of all in certain localities, and it is obvious that in the different districts where studies have been made, much the same series of variations and teratological malformations have been encountered, though the forms with the stalked petals or ovary appear to be more restricted. It is proven that these are not environmentally produced, at least in the sense that their recurrence from the same root year after year is independent of environment. We can only suppose that such rootstocks have been produced from particular seeds in which a mutation had occurred, giving rise to one of the many aberrant conditions found. The species is in an unstable condition in the same sense in which I have used that term for *Oenothera Lamarckiana*. It is possible that cytological study of *T. grandiflorum* might reveal the basis of this unstable condition, as it has done to some extent in *Oenothera*, and a careful study should be undertaken with this possibility in view. It seems evident that *T. grandiflorum* is mutating in much the same sense that the term can be used for *Æ. Lamarckiana*. In *T. grandiflorum*, however, the mutations are for the most part teratological. It is important to discover, if possible, the fundamental difference between the condition of the germ-plasm of *T. grandiflorum* in which the variations are chiefly in number and arrangement of parts, and the condition in *Oenothera* in which the variations are better coördinated — changes occurring simultaneously in all parts usually without dislocation of their relation to each other. It must be supposed that a redistribution

of some of the germinal materials has taken place, but the nature of that redistribution is at present unknown.

Such wide variations in *Trillium* as the formation of long petioles from sessile-leaved species, and the multiplication of the number of the leaf whorls, with internodes between them, are, however, not obviously teratological; and in the former case they are similar to ordinary specific differences in the genus, while in the latter they, if constant, might well serve as the basis of a distinct genus. Thus the long petioles and short stems of *T. petiolatum* furnish its most striking distinction from such species as *T. sessile*, and it is very tempting to assume that *T. petiolatum* was derived from a sessile-leaved, long-stemmed species in the same way that the typical condition of the variety *variegatum* now apparently arises from *T. grandiflorum*. These suggestions may seem to systematists bold, but we have reached a point where our experimental knowledge of variation must be applied directly in any discussion of the phylogeny and relationships of particular species. The known variations of species of *Trillium* furnish a more reasonable basis for an evolutionary reconstruction than hypothetical continuous variations which experiment seems to show are not usually inherited.

PARIS L.

The Eurasian genus *Paris* is mentioned here on account of its close affinities to *Trillium*. Just as *Trillium* is chiefly North American, with a few species closely related to *T. erectum* in northeastern Asia and one species (*T. Govaniana* Wall.) in the Himalayas; so *Paris* is almost entirely Asiatic, with one species (*P. quadrifolia* L.) extending into Europe. The genus *Paris* was probably derived from the ancestors of the group of four species, relatives of *Trillium erectum*, occurring in Japan, Manchuria, and eastern Siberia. Some 30 species have been described, mostly from China, but including 3 from Siberia, 3 from Japan, and 2 from Thibet.

Bearing in mind the probable origin of the genus, its differences from *Trillium* are of much interest. The two may be compared as follows:

TRILLIUM L.

PARIS L.

Sepals and petals 3 each; petals larger and more or less colored.¹

Sepals and petals 4-6 each; petals smaller than sepals, sometimes very long and slender.

Stamens 6, filaments filiform, connective not prolonged or only slightly prolonged beyond the anthers.²

Stamens 8-12, filaments short, anthers with an elongated connective.

Ovary 3-celled, or 1-celled with parietal placentation in *T. grandiflorum* and sometimes in teratological specimens.

Ovary 4-5-celled, or 1-celled with parietal placentation.

Styles 3.

Styles 4-5.

Leaves normally a whorl of 3.

Leaves a whorl of 4 or more.

Several significant facts point to the direct origin of *Paris* from the *T. erectum* group of *Trillium*, probably through *Trillium tetrphylla* Gray and *Paris quadrifolia* L. Comparing *T. erectum* with *P. quadrifolia* the main differences are: (1) the parts in fours instead of threes; (2) the greenish reduced petals of the latter; and (3) the greatly elongated connectives of the anthers. Every one of these conditions is more or less completely duplicated in teratological variations of *Trillium*. Plants with all the parts in fours occur occasionally in a number of species; a virescent condition of the petals is not uncommon; in *T. decumbens* the anther connectives are prolonged beyond the pollen-sacs. The one-celled condition of the ovary in some species of *Paris* is found as a relatively common teratological variation in *Trillium*.

Paris tetrphylla Gray³ forms a transition between the group of *Trillia* closely related to *T. erectum* in northeastern Asia and *Paris quadrifolia*, for its anther connectives agree with those of most species of *Trillium* in not being at all pro-

¹ Except in teratological specimens.

² Except in teratological specimens and in *T. decumbens* Harb.

³ This species is found in China, Japan, and the Himalayan region. See Gray, *Asa. Mem. Am. Acad. N. S.* 6: 412. 1858-59.

longed. We may therefore assume, as the other facts suggest, that this variation occurred independently of the others, and perhaps subsequently. On the other hand, the reduction in petals in *Trillium* (leading towards *Paris*) displays itself particularly in *T. Smallii* Maxim., in which the petals may be more or less reduced or absent.

The fact that certain teratological conditions in one genus frequently resemble the normal condition in a related genus, as we noted in a previous paragraph, shows that variations tend to follow certain paths. These variations must result from the structure of the germ-plasm, and may be compared with lines of cleavage or fracture. They apparently result from certain weaknesses in the structure of the germ-plasm, and they are apparently not environmentally produced (unless in the sense of large responses to small stimuli), but reappear generation after generation through long periods of time. They represent the unstable nature of certain elements of the germ-plasm, and are apparently, when reproduced from seed, themselves unstable. This is a matter on which more extensive data are urgently needed; e.g., will a 4-parted *Trillium* come true from seed, or how will its peculiarity be inherited, if at all? And will a partly double *T. grandiflorum* which reappears each year from the same rootstalk reproduce itself from seed? It is greatly to be hoped that breeding experiments with teratological plants will be undertaken to determine this point. One is strongly inclined to believe that such peculiarities as polymery and doubling will be reproduced in some, at least, of the offspring. Experiments with double garden flowers of course point to this conclusion.

On the other hand, it appears that somatic variations, such as fasciation, which are not at all inherited in some genera, have become a constant feature of the genus in other genera, e.g., *Celosia*. We have at present no means of knowing how the unstable and non-inherited or partially inherited teratological variations of one genus may give rise to the stable and completely inherited condition of a derived genus; but it is a legitimate interpretation of the facts to suppose that

something like this has happened in the origin of many genera.

The differences between *Trillium* and *Paris* may, as we have seen, be reduced to three; but these, so far as we know from present variations, are apparently independent of each other as a rule. Three mutations are required to account for the origin of a typical *Paris* from a *Trillium* (two if we consider *P. tetraphylla*). Other intermediate species containing one or two of these features only have recently been described by L  veill   from China. Thus *P. Dunniana* L  vl. and *P. aprica* L  vl. also have the anther connectives scarcely, if at all, prolonged, while in *P. atrata* L  vl. the petals are longer than the sepals. We may, therefore, assume a considerable amount of elimination of such forms, perhaps through their own instability in inheritance, until finally a stable combination was reached which has since given rise to the various species of *Paris* through another group of variations. It is greatly to be hoped that some one will undertake crossing experiments with *Paris* and *Trillium*, for they would throw much light on these questions.

MEDEOLA Gronov.

A monotypic genus of eastern North America.

1. *Medeola virginiana* L. Sp. Pl. 339. 1753.

Gyromia virginica Nutt. Gen. 1: 238. 1818; Lamarck, Encyc. Meth. 4: 4. 1796; Illustr. Gen. Tab. 2: pl. 266, fig. 2. 1823; Barton, Elem. of Bot. pl. 14. 1803; Curt. Bot. Mag. pl. 1316. 1816; Meehan, Native Flowers 2: 157. pl. 40. 1879.

Nova Scotia and New Brunswick to Ontario, Minnesota, Florida, and Tennessee.

The genus *Medeola* is remarkably distinct from its nearest relative, *Trillium*, yet there is no question of its affiliation, on the one hand with *Trillium* and on the other hand with *Paris*. The differences enumerated below would seem to indicate that *Medeola* is the sole survivor of a group of North American forms which has disappeared.

In his classical paper¹ in which he compared the flora of eastern North America with that of Japan, pointing out the many striking similarities, Asa Gray regards *Paris hexaphylla* as the Japanese counterpart of *Medeola virginiana* L.

MEDEOLA Gronov.

TRILLIUM L.

Deciduous wool on stem.	No wool on stem.
Leaves in 2 (rarely 3) whorls; lower whorl 4-10 leaves.	Leaves in 1 whorl ² of normally 3 leaves.
Flowers in a sessile umbel, small, greenish yellow.	A single flower, usually dark red or white.
Six perianth segments alike.	Three sepals; 3 petals.

The differences from *Trillium* are much greater than in the case of *Paris*. The presence of 2, or sometimes 3, whorls of leaves recalls a not infrequent teratological condition in *Trillium*, while the variable number of leaves in the lower whorl agrees with the condition in the genus *Paris*. The umbel of flowers is a marked progressive step, while the lack of differentiation of calyx and corolla is a primitive or reactionary condition, again resembling certain teratological specimens in *Trillium*. The fluffy wool on the stems is a positive character of whose origin we know nothing, but there is no reason to believe that it has any selective value.

It is scarcely to be supposed that *Medeola* would cross with *Trillium*, but the attempt would be worth making.

¹ Gray, Asa. Diagnostic characters of new species of phanerogamous plants, collected in Japan by Charles Wright, Botanist to the North Pacific Exploring Expedition. With observations upon the relations of the Japanese flora to that of North America, and of other parts of the northern temperate zone. Mem. Am. Acad. II. 6: 377-452. 1859.

² Teratological specimens occur having 2 or 3 whorls.

EXPLANATION OF PLATE

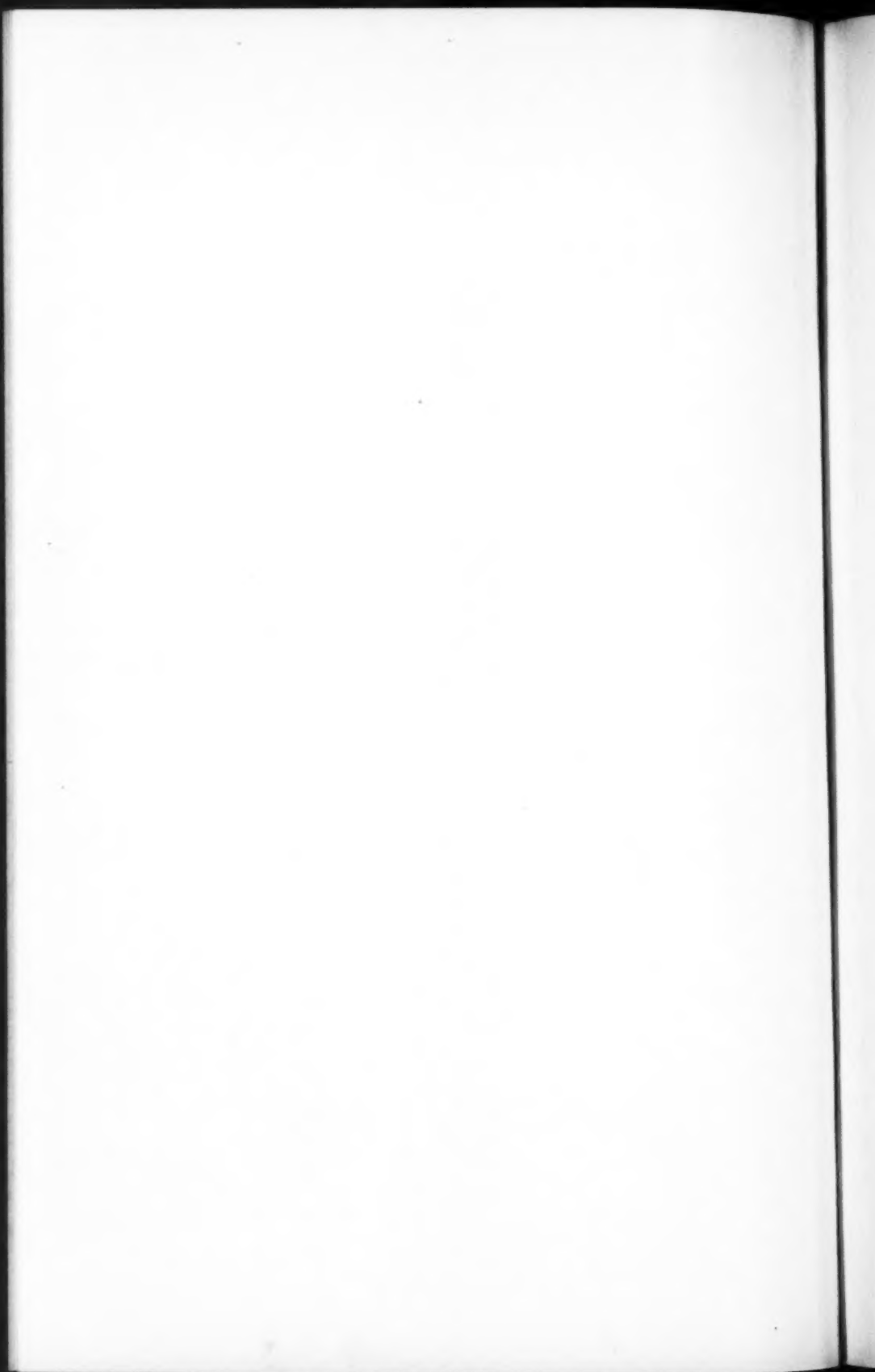
PLATE 6

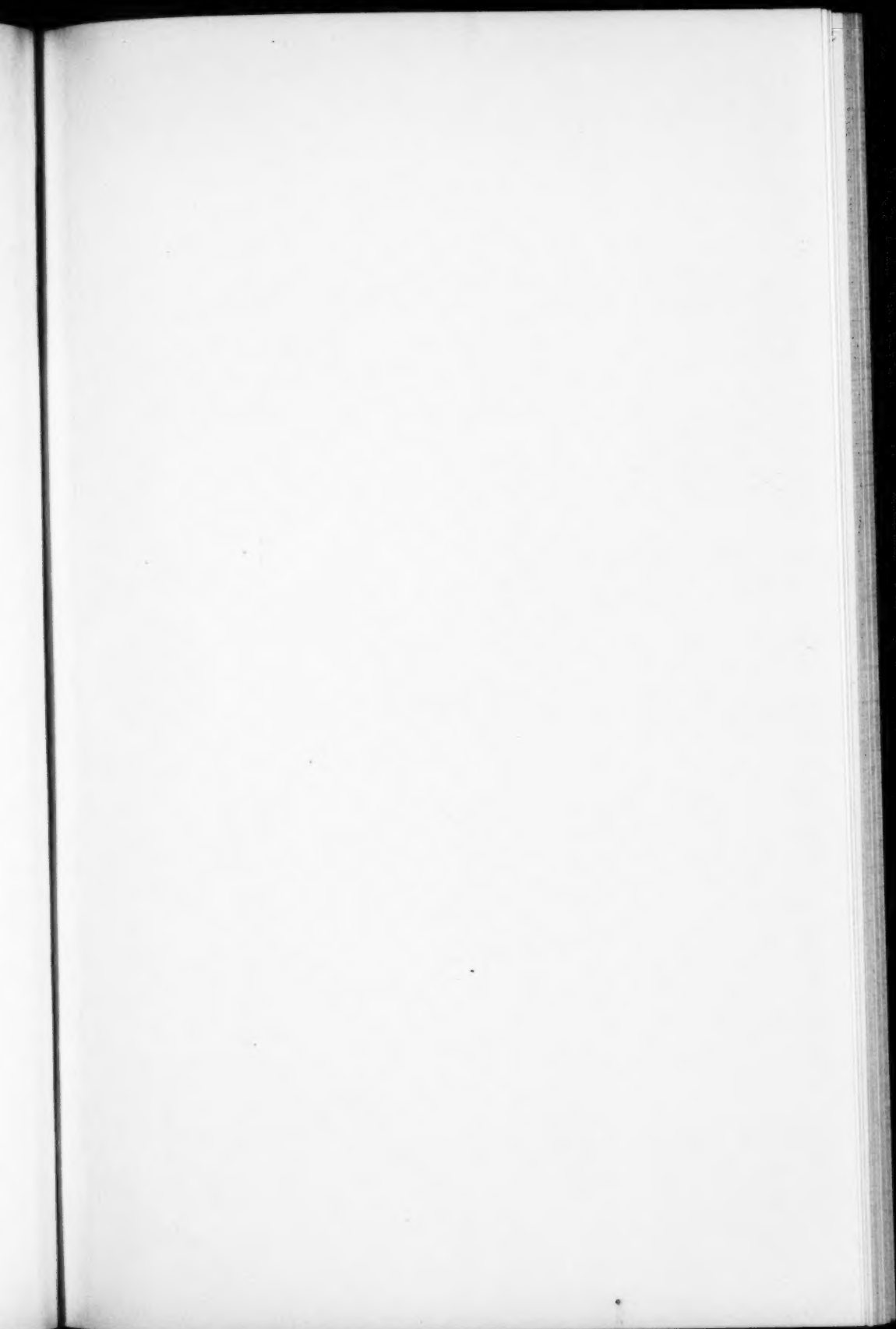
Fig. 1. *Trillium venosum* Gates. From cotype specimen in Mo. Bot. Gard. Herb., collected at Dry Buck, Boise Co., Idaho, by J. F. Macbride 847.

Fig. 2. *Trillium ovatum* Pursh var. *stenosepalum* Gates. From type specimen in Mo. Bot. Gard. Herb., collected at Helena, Montana, by Alderson.



GATES—THE GENUS TRILLIUM





EXPLANATION OF PLATE

PLATE 7

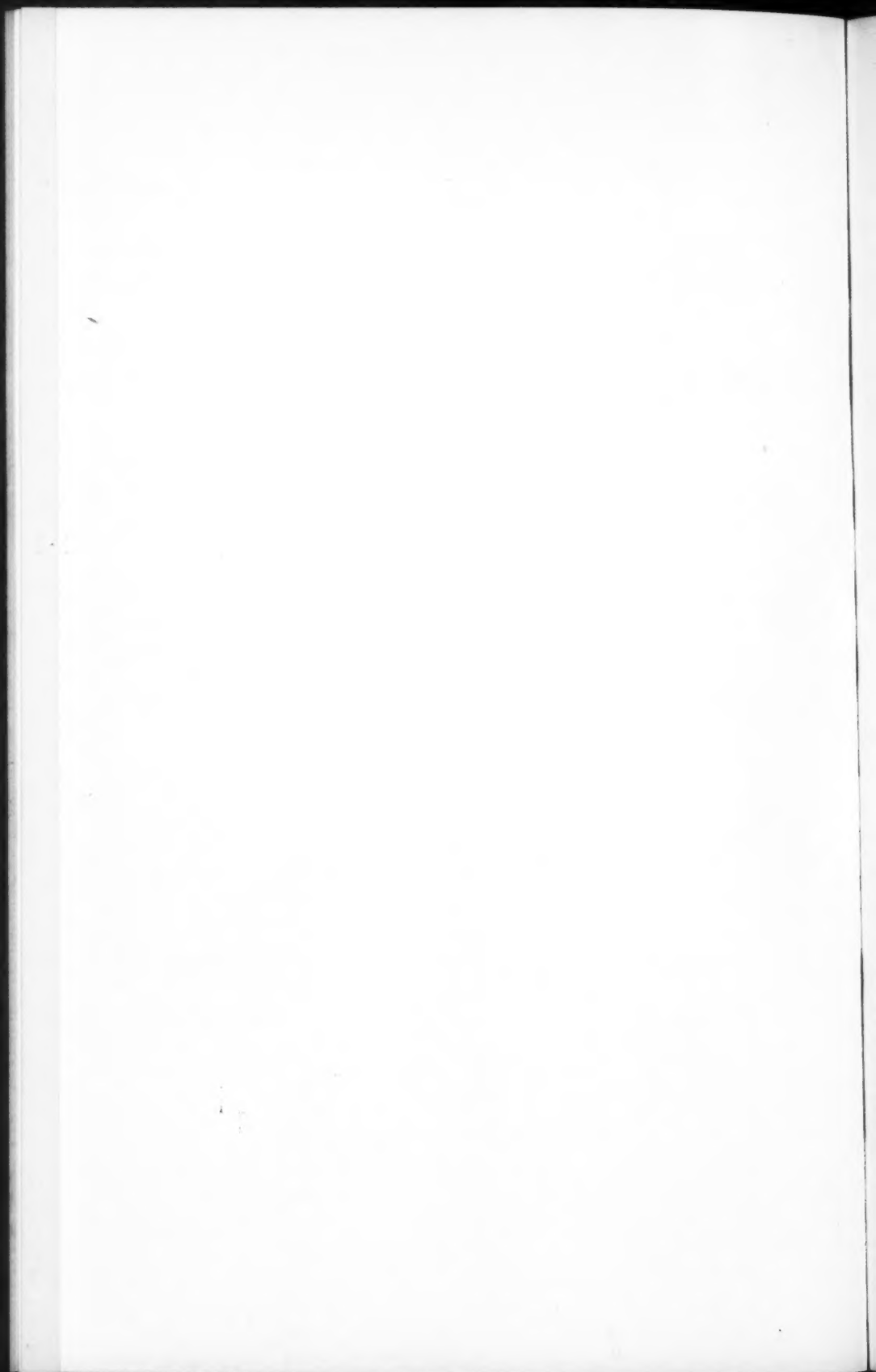
Fig. 1. *Trillium giganteum* (H. & A.) Heller var. *chloropetalum* (Torr.) Gates. From specimen in Mo. Bot. Gard. Herb., collected at Humbug Creek, Siskiyou Co., California, by George D. Butler 1168.

Fig. 2. *Trillium luteum* (Muhl.) Harbison. From specimen in Mo. Bot. Gard. Herb., collected at Clemson College, Oconee Co., South Carolina, by H. D. House 1789.

Fig. 3. *Trillium luteum* var. *latipetalum* Gates. From specimen in Mo. Bot. Gard. Herb., collected at Clemson College, Oconee Co., South Carolina, by H. D. House 1789.



GATES—THE GENUS TRILLIUM



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EXPLANATION OF PLATE

PLATE 8

Trillium giganteum (H. & A.) Heller var. *angustipetalum* (Torr.)
Gates. From specimen in Univ. Cal. Herb., collected in the foothills
near Stanford University, Santa Clara Co., California, by C. F.
Baker 306.

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